Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

NOVEMBER, 1952

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# 115 extra ideas in Iron and Steel Engineer this month!

TRADE and business publications are one of industry's most important sources of information. And as readers know, these publications not only contain informative material in their editorial sections, but also offer a wealth of *extra* ideas in their advertising pages.

That's why these days, smart readers are giving both parts an extra-thorough combing. With costs on the rise and greater output a must, ideas that help a company boost its efficiency are more valuable today than they have ever been.

In this issue of Iron and Steel Engineer, there are 115 advertisements, many of them containing ideas that may help *your* business. And if you manufacture or buy machinery of any kind, we believe you'll find helpful information in the Timken® tapered roller bearing advertisements that appear regularly in this publication. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

NOT JUST A BALL NOT JUST A ROLLER THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION

# what are the FACTS ABOUT SAFETY SWITCHES?

**1 IS "INTERNAL HEATING" IN SAFETY SWITCHES IMPORTANT?**

Engineering research fully authenticated by outstanding authorities shows "internal heating" in Safety Switches to be the principal cause of Safety Switch failures.

**2 HOW DOES "INTERNAL HEATING" CAUSE SAFETY SWITCH FAILURES?**

By literally baking the life out of Safety Switch parts. It causes insulating materials to disintegrate, metal parts to warp and corrode, so switches either become inoperative or "burn up" through inability to carry the load.

**3 WHAT CAUSES "INTERNAL HEATING" IN SAFETY SWITCHES?**

In properly constructed Safety Switches, fuses are responsible almost exclusively for "internal heating." This is no criticism of fuses; it is unavoidable. Any fuse carrying its rated load *must* be near its melting point if it is to perform properly when an overload occurs. Any metal operating *near* its melting point must be *hot* and fuse links *are* hot, with temperatures running as high as 700 degrees Fahrenheit.

**4 HOW CAN THE TROUBLE FROM "INTERNAL HEATING" BE OVERCOME?**

As the adequate enclosure so fundamental to *safety* in Safety Switches makes thorough venting of the trapped heated air impossible, the only escape from the ravages of "internal heating" can come through selecting materials for the internal structure and designing this structure to successfully withstand the unavoidable heat conditions to be met in service.

CUTLER-HAMMER
SAFETY SWITCHES
C-H

**5 WHAT SAFETY SWITCHES AVOID "INTERNAL HEATING" TROUBLES?**

Cutler-Hammer Safety Switches avoid these troubles. They were completely redesigned over *ten years* ago to beat "internal heating" when engineering research clearly indicated the need for *such* Safety Switches. *Years* of experience now prove the Cutler-Hammer claim of better Safety Switch performance far more than a mere promise; it is a proven *fact*. Ask the men who use them. CUTLER-HAMMER, Inc., 1327 St. Paul Ave., Milwaukee 1, Wis.

IRON AND STEEL ENGINEER: published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 29, No. 11.

# THE AETNA-STANDARD ENGINEERING COMPANY

## Leading Engineers and Builders of CONTINUOUS BUTT WELD PIPE MILLS

ASSOCIATED COMPANIES

**Head Wrightson Machine Company, Ltd., Middlesbrough, England**—Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.

**Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.**

**M. Castellvi, Inc., New York, N. Y.**—Mexico, Central and South America.

**Societe de Constructions de Montbard, Paris, France**—France, Belgium, Holland, Luxembourg, Switzerland.

**Demag Aktiengesellschaft, Duisburg, Germany**—Germany, Austria, Yugoslavia, Greece, Turkey, Egypt.

**Compagnia Italiana Forme Acciaio, Milano, Italy**—Italy.

**Aetna-Japan Company, Ltd., Tokyo, Japan**—Japan.

**Hale & Kullgren, Inc., Akron, Ohio**—Representative for the Rubber Industry.

*Designers and Builders to the Ferrous, Non-Ferrous, Leather and Rubber Industries*

# Aetna-Standard

**THE AETNA-STANDARD ENGINEERING COMPANY • PITTSBURGH, PA.**

**Plants in Warren, Ohio • Ellwood City, Pennsylvania**

FROM THE TOP STEEL PRODUCER . . .

TO A LEADING CHEMICAL HOUSE,

A YEAST COMPANY

AND A MEAT PACKER . . .

# Heat Prover SERVES 62 DIFFERENT COMPANIES IN THE GREAT CHICAGO INDUSTRIAL AREA!

The Cities Service Heat Prover is graphically proving its worth to all kinds of industry in the Chicago area and elsewhere throughout the country.

62 different companies, producing everything from steel to beef, have found the Heat Prover an important aid to increased production and big dollar economy.

**WHEREVER A FURNACE OPERATION IS INVOLVED,** Heat Prover can help increase productivity by providing:

1. **Rapid, continuous sampling.**
2. **Simultaneous reading of oxygen and combustibles.**
3. **Direct measurement of oxygen and combustibles.**
4. **Easy portability.**
5. **No maintenance; no re-calibration.**

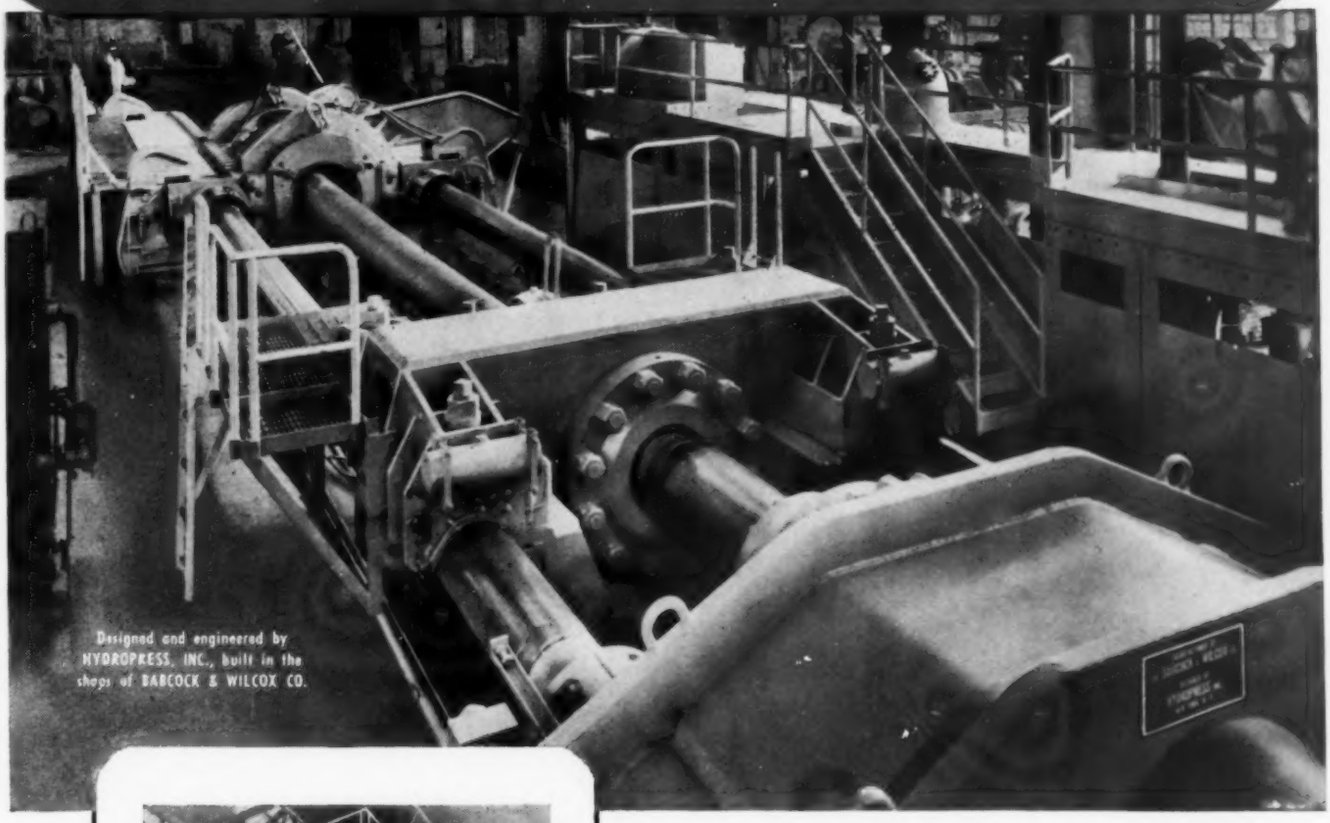
**REMEMBER:** Heat Prover is not an instrument you buy but a service we supply. Contact the Cities Service office in your area and learn how Heat Prover can serve you . . . or write CITIES SERVICE OIL COMPANY, Dept. K-17, Sixty Wall Tower, New York City 5.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

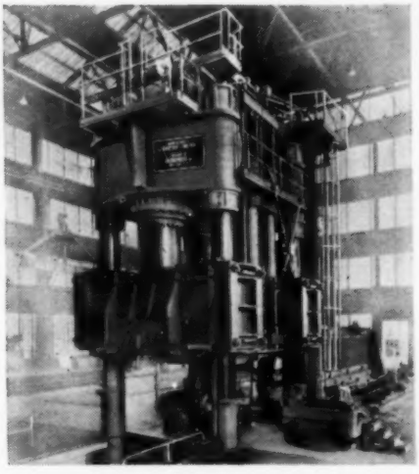
# "No other such equipment exists in America today..."

*— says BABCOCK & WILCOX for whom HYDROPRESS, INC. designed and engineered it*



Designed and engineered by HYDROPRESS, INC., built in the shops of BABCOCK & WILCOX CO.

Horizontal Hydraulic Push Bench — largest in America for this purpose — for drawing Alloy and Carbon Steel Ingots or Billets of varying cross sections into seamless tubes and high pressure vessels from a minimum of 8" I.D. up to max. 26" I.D., 4½" Wall Thickness and 22 feet length—at BABCOCK & WILCOX, Barberton, Ohio.



HYDROPRESS, INC. designed and engineered also "The Nation's Largest Press for Forming Boiler Drum Plate", a 6,500 Ton Hydraulic Piercing and Bending Press; a multi-purpose press for forming the heaviest Steel Plate ever rolled—up to max. 42 feet length and 6" wall thickness — into Boiler Drum Sections.

***The products made from thick-walled hollow forgings on that installation are sections for steam lines and boiler headers; there are however other uses in the chemical and processing industries, in the petroleum industry and in many others.***

**LOEWY**

**HYDROPRESS INC**

ENGINEERS • CONTRACTORS

*Rolling Mills • Hydraulic Presses • Pipe Testing Machines • Special Pipe Mill Equipment • Accumulators • Pumps • Die Casting Machines*

**350-G Fifth Avenue (Empire State Building) NEW YORK 1, N. Y.**

*BIRMINGHAM • CHICAGO • CLEVELAND • DETROIT • LOS ANGELES • PHOENIX • SAN FRANCISCO • SEATTLE • WASHINGTON, D. C. • WHEELING*

*GENOA, ITALY • LONDON, ENGLAND • MADRID, SPAIN • PARIS, FRANCE • PHILIPPINE ISLANDS*

# MACHINE SHOPS at MESTA

## PLANERS . . .

Machining Large Gear Drive Base on a MESTA Heavy Duty Planer . . .

Designers and Builders of Complete Steel Plants

**MESTA MACHINE COMPANY**
Pittsburgh, Pa.

LOOK for these NAMES when buying Motor Control

1 LINE-ARC Contactors
2 TIME-CURRENT Acceleration (D-c)
3 FREQUENCY RELAY Acceleration (A-c)
4 WRIGHT CIRCUIT Hoist Control (D-c)
5 YOUNGSTOWN Hoist Limit Steps
6 TYPE WB Brakes
7 CAM Master Switches
8 MANUAL-MAGNETIC Disconnect Switches
9 CONTRA-TORQUE Hoist Control (A-c)
10 TAB-WELD Resistors

These FUNCTIONAL NAMES Speak for Themselves

TRADE MARK
TAB WELD
PLATE RESISTORS

# Save Initial Cost and more

The welded grid assembly is shown here as a unit resting on narrow iron straps above its end frame, support rods, and spacers.

Save up to 1/6th on maintenance and inspection costs with EC&M TAB-WELD Plate Resistors.

No burning at grid-eyes or at tap-plates—ohmic value is stabilized—made of corrosion-resistant alloy steel—non-breakable—negligible resistance change between cold and maximum working temperatures—dimensionally stable, high dielectric, non-carbonizing insulating spacers. Also, accurate mounting hole dimensions maintained regardless of variations in length of grid stack.

Use these advantages to pare down upkeep costs. TAB-WELD construction saves the initial cost and more—specify EC&M Bulletin 942 TAB-WELD Plate Resistors.

Installation of TAB-WELD Resistors used with EC&M quadruplex controller.

**THE ELECTRIC CONTROLLER & MFG. CO.**
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

Lee Wilson

# ANNEALING FURNACE DATA SHEET

NUMBER SEVEN

**PORTABLE BASE SINGLE STACK ANNEALING SYSTEM**

## REVOLUTIONARY NEW ANNEALING SYSTEM FOR LARGE STRIP & TIN PLATE MILLS

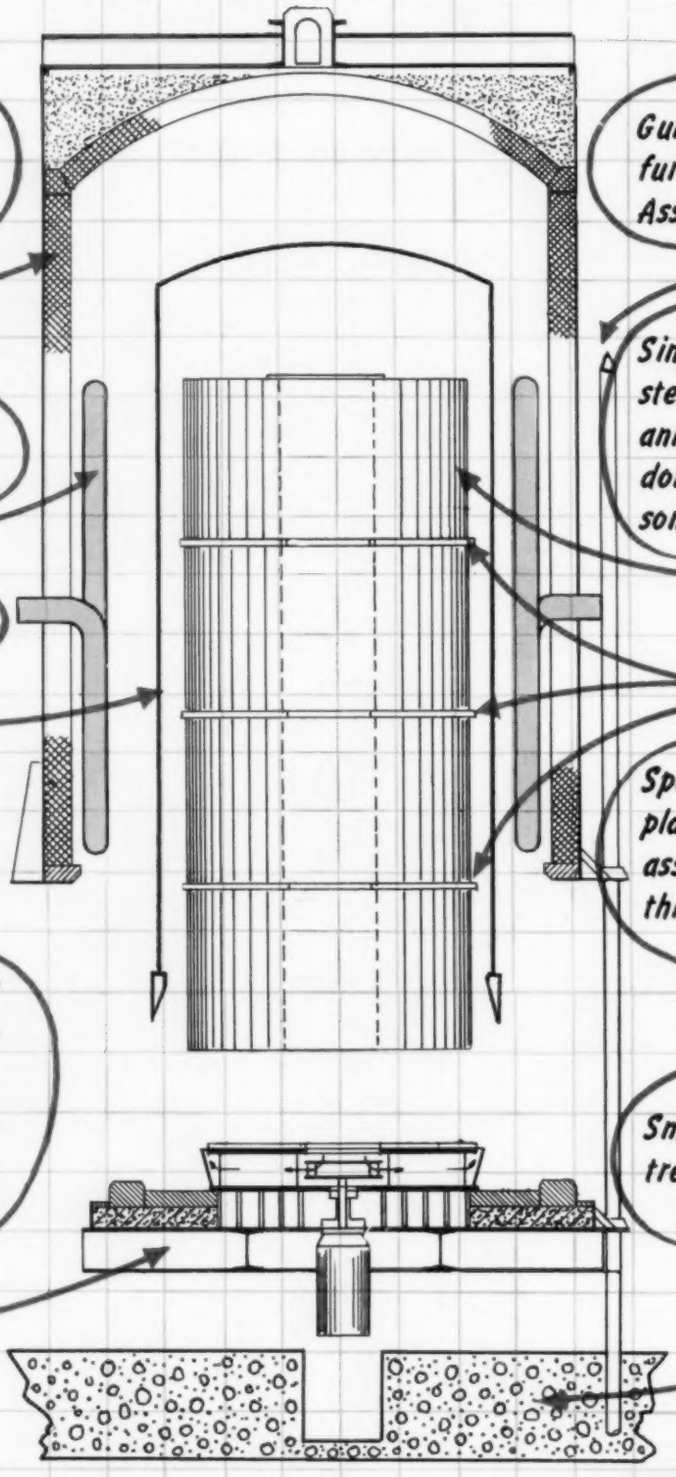
*Single-stack furnace heats and cools down faster, more efficiently. Easier to handle with lighter equipment.*

*Guide-post guides both furnace and portable base. Assures perfect alignment.*

*Single stack of steel gets steady, even, easily controlled annealing. A better job can be done faster with the Lee Wilson single-stack system.*

*"O" type heating tube gives faster, more regulated heating*

*Light, easy to store inner cover*



*Special swirl design convector plates uniformly apply heat assuring even annealing throughout coil.*

*Completely portable base and fan unit can be carried by light crane equipment to maintenance bay if repairs are needed. Extra floater base can be substituted immediately. No down time for repairs.*

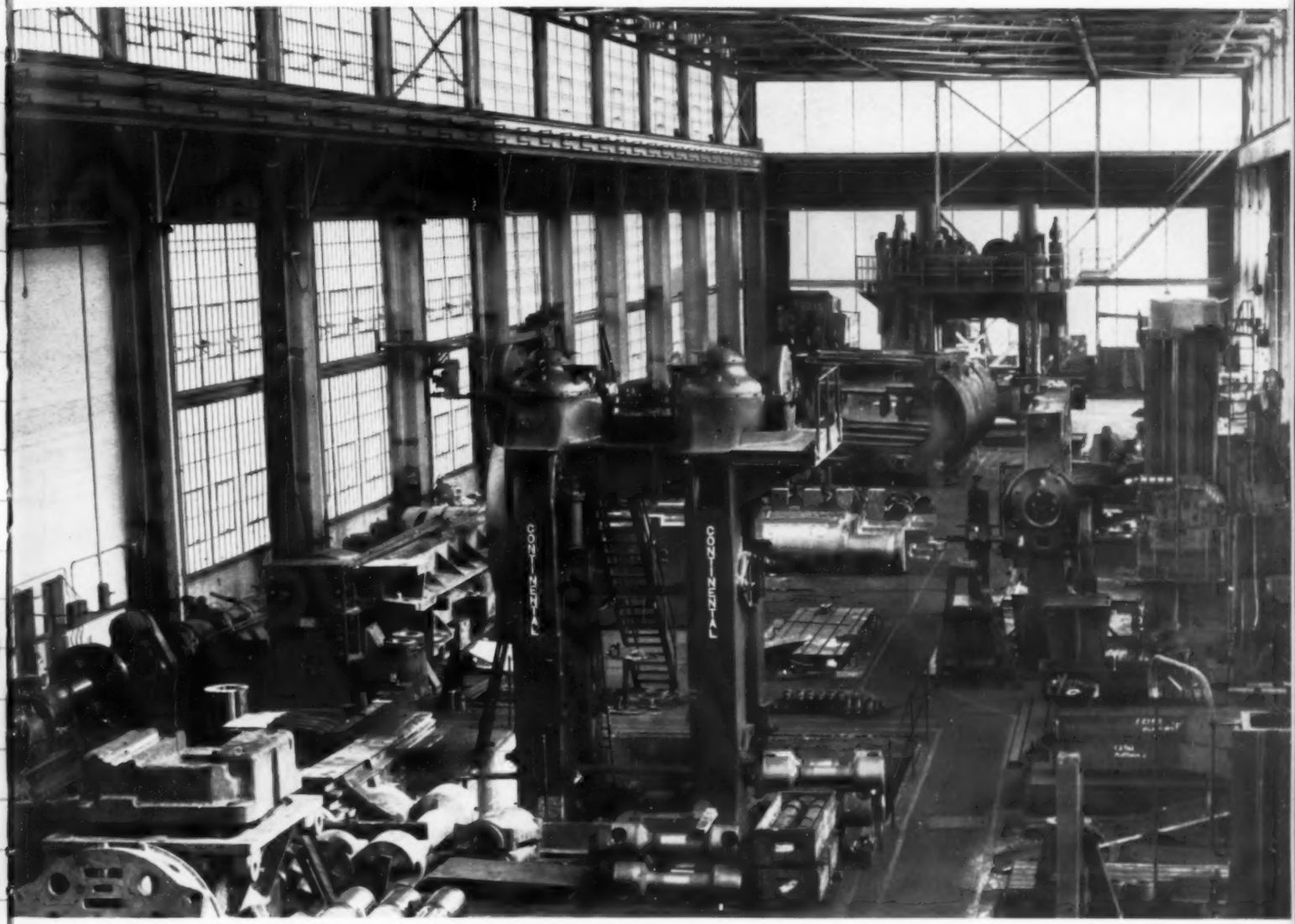
*Small, easily constructed fan trench. No elaborate and expensive pits are needed.*

Lee Wilson ENGINEERING COMPANY, INC. CLEVELAND, OHIO

**Get all the facts about this amazing system — write for Brochure**

# CONTINENTAL

## SHOP ASSEMBLY OF A 46" BLOOMING-SLABBING MILL AND 56" TANDEM COLD STRIP MILL AT EAST CHICAGO PLANT




## Complete Rolling Mill Installations

SLABBING MILLS
UNIVERSAL MILLS
PLATE MILLS
HOT STRIP MILLS
COLD STRIP MILLS
TEMPER MILLS

Mills complete with Auxiliary Equipment

★ ★ ★

CONTINENTAL CHIPPER
ROLL LATHES
SPECIAL MACHINERY

BLOOMING MILLS
STRUCTURAL MILLS
RAIL MILLS
BILLET MILLS
ROD MILLS
MERCHANT MILLS

CASTINGS—carbon and alloy steel from 20 to 250,000 pounds

ROLLS—iron, alloy iron and steel rolls for all types of rolling mills

WELDMENTS—fabricated steel plate, or cast-weld design.

*Plants* at
East Chicago, Ind. • Wheeling, W. Va. • Pittsburgh, Pa.

CHICAGO • PITTSBURGH

CONTINENTAL
Foundry & Machine
Company

# Why LINK-BELT belt conveyors are first choice in so many steel mills...

## LINK-BELT engineering experience plus quality components combine to cut handling costs

Yes, in steel mills everywhere, Link-Belt is first choice in belt conveyors. Whether your job is large or small, Link-Belt can apply unequalled engineering experience to meet the conditions of your particular bulk handling requirements.

Link-Belt builds a complete line of quality components. Our conveyor engineers can choose from all types and sizes of idlers, trippers and terminal machinery to match your exact requirements.

Link-Belt can also supply all related equipment—other types of conveyors, feeders, elevators, car dumpers and shakers. And Link-Belt will build your supporting structures and enclosures . . . install the job completely if desired.

Link-Belt will gladly work with your engineers, consultants and builders of mill and process equipment. Get in touch with your nearest Link-Belt office.

12,747-F

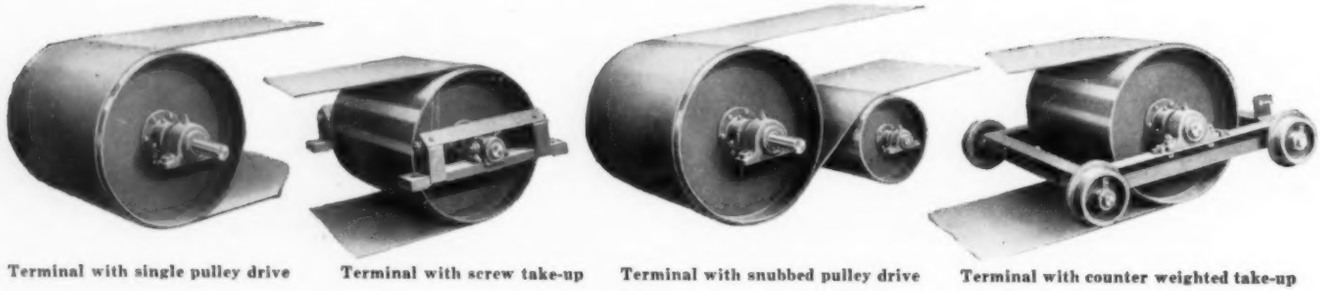
**LINK-BELT COMPANY:** Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices in Principal Cities.

Magnetite ore is carried from crushing plant on this 1500 ft. long belt conveyor equipped with 48 in. wide Link-Belt roller bearing idlers.

**LINK-BELT**

**BELT CONVEYOR EQUIPMENT**

## LINK-BELT Pre-Selected Terminals—the right equipment for every requirement



Terminal with single pulley drive

Terminal with screw take-up

Terminal with snubbed pulley drive

Terminal with counter weighted take-up

# Major Tin Plate Producer Steps Up Production 15% Using **PALMOSHIELD**

## *Sets production records using domestic Palmoshield in place of imported palm oil*

After tests covering a number of years, a leading steel company adopted Palmoshield as a replacement for palm oil in cold rolling operations. Recently over a run of 20 consecutive shifts, production was stepped up 15% over the average output with imported oil. This increase was made with no additional investment, no increase in labor force, no extra machines and no changes in mill operation. Yet 115 tons of steel were rolled for every 100 before.

### *Two Mill-Tested Benefits*

Actual mill-experience in dozens of plants has proven these advantages of Palmoshield:

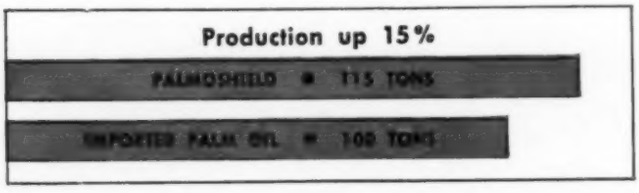
*To Purchasing Agents.* The price of Palmoshield is not artificially controlled. It rises and falls freely with the domestic fat market. Within the past year users have received several voluntary price cuts.

*To Operators.* Mill experience indicates that the use of Palmoshield improves production.

*Palmoshield requires absolutely no changes in rolling mill operation.*

*Palmoshield makes steel quicker to gauge and shape.*

*Water break tests show that Palmoshield washes grease-free under conventional cleaning operations.*




### *Quick Acceptance by steel producers*

Nearly two-thirds of the major tin plate mills in this country and Canada are now using Palmoshield either in regular mill operations or for on-the-job-test runs. One company using Palmoshield for the first time was only 10 tons shy of the daily record. Another broke the single-shift record. And still another broke both 8-hour and 24-hour records.

### *4 Advantages of Palmoshield*

Palmoshield is produced in the heart of the steel industry. Users are not dependent on overseas shipment.

Palmoshield is made from domestic materials freely available in sufficient quantities to supply all American steel production.

Palmoshield need not be stockpiled by the user, yet it does not deteriorate in storage.

Palmoshield is subject to exact chemical control. Free fatty acid content can be controlled to within ½%.

### *Can Palmoshield step up your production?*

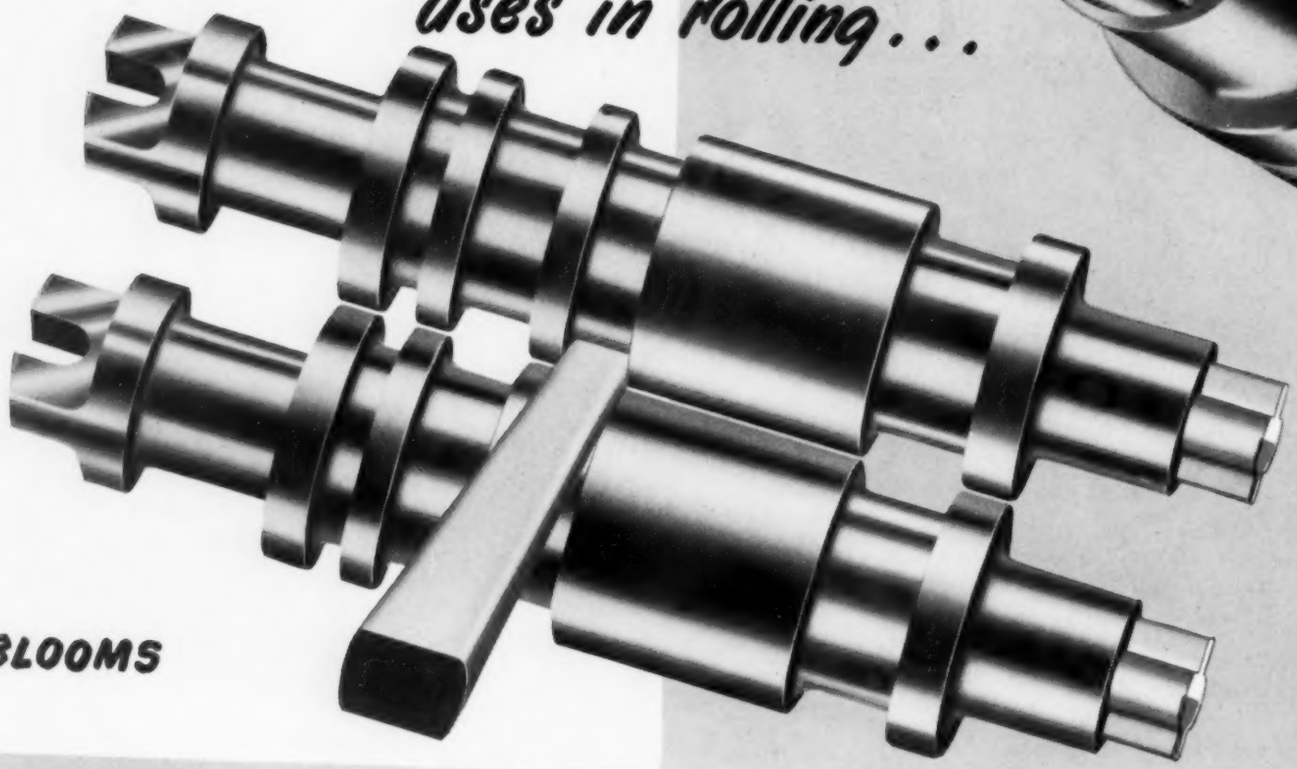
On request an Ironsides representative will give you facts on Palmoshield to help you set up a test program in your mill.

Palmoshield is available for same-day shipment in 55-gallon drums and tank car lots. For full information write The Ironsides Company, 270 West Mound Street, Columbus, Ohio.

SPECIAL LUBRICANTS and PRESERVATIVES

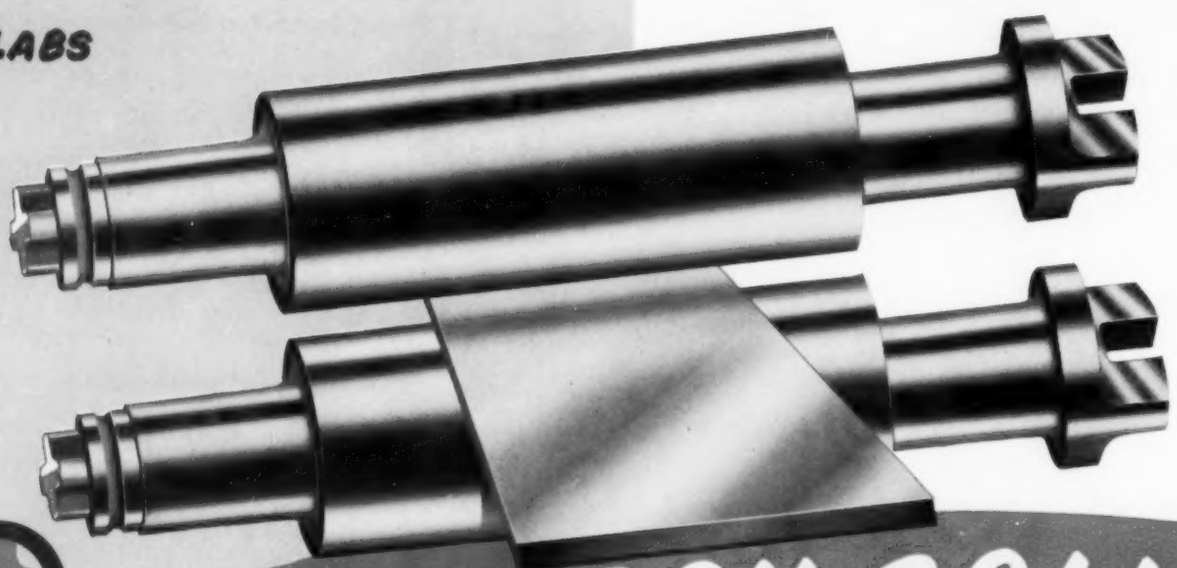
**IRONSIDES** SHIELD PRODUCTS **PALMOSHIELD**

# PHOENIX "A" Alloy Steel ROLLS are color marked for specific uses in rolling...



BLOOMS

SLABS



P.R.W.

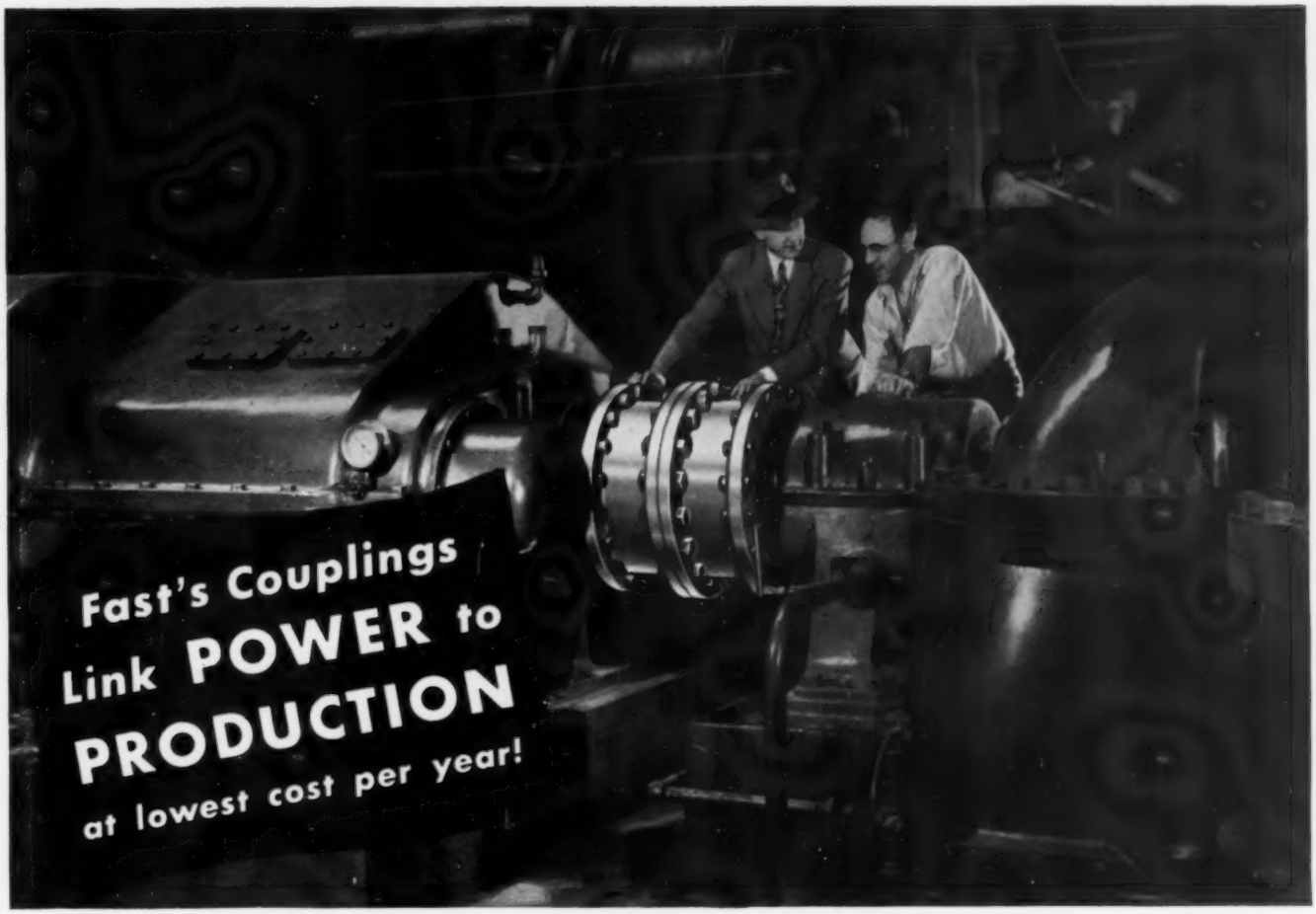
# PITTSBURGH ROLLS

PITTSBURGH ROLLS DIVISION of BLAW-KNOX COMPANY • PITTSBURGH, PA.

**OTHER PITTSBURGH ROLL TYPES**

Chill
Moly Chill
Special Rail Finishing
Phoenix "K"
Pittsburgh Grade 25
Pittsburgh Grade 35
Pittsburgh Grade 45
Pittsburgh Grade 55
Pittsburgh Grade Special Process
Phoenixloy
Phoenix Metal
Phoenix Metal Master

Carbon Steel




# Over half a million FAST'S Couplings now in use!

THROUGHOUT industry, Fast's are rated the most dependable couplings on the market... to the tune of over half a million now in service! Year in, year out, they continue to *outlast the equipment they connect* . . . save time, maintenance and money by eliminating costly coupling failures.

Actual cases on record show many Fast's Couplings have been in operation for 25 and 30 years without trouble. And every major producer of high-speed equipment now uses Fast's!

Solve your coupling worries! Write today for full details on Fast's Couplings and Koppers Engineering Service to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 311 Scott St., Baltimore 3, Maryland.

## Here's How FAST'S Save You Money

***Free Service***—Koppers free engineering service assures you the right coupling for the job.

***Rugged Construction***—Fast's still maintains its original design, without basic change or sacrifice in size or materials. Result: freedom from expensive coupling failures.

***Lowest Cost per Year***—Fast's Couplings usually outlast equipment they connect. Their cost may be spread over many years!

KOPPERS®

**FAST'S**
THE ORIGINAL
GEAR-TYPE
**Couplings**

**INDUSTRY'S STANDARD FOR 32 YEARS**

**KOPPERS COMPANY, INC.,** *Fast's Coupling Dept.*
**311 Scott St., Baltimore 3, Md.**

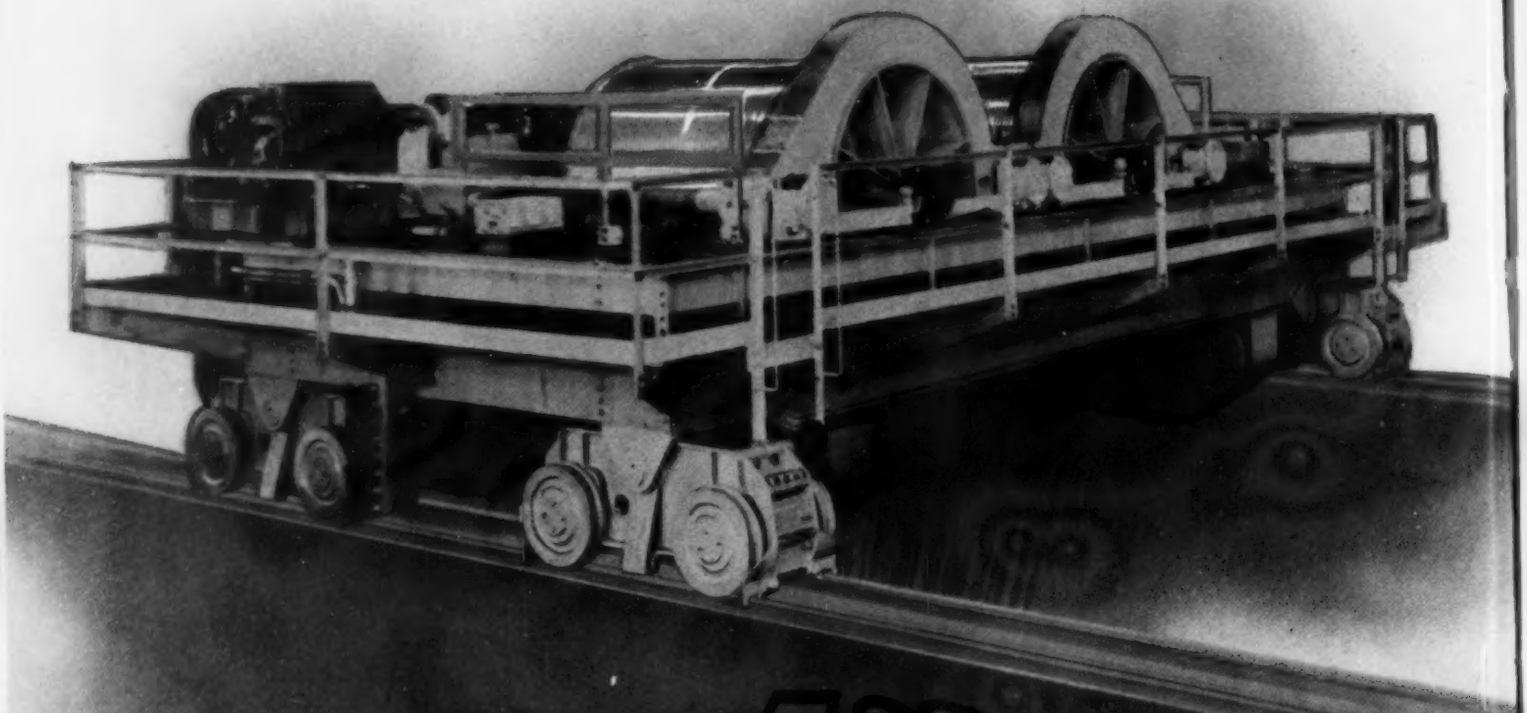
*Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.*

*Name* .....

*Company* .....

*Address* .....

*City* ..... *Zone* ..... *State* .....



# TROLLEY FOR THE WORLD'S BIGGEST CRANE BY Alliance

Paul Bunyan used to brag about threading a needle with his enormous hands . . . but he has little on Alliance trolleys. Swiftly, but with the accuracy and control of a micrometer, the world's largest crane moves tons of molten steel with utmost safety.

The trolley is equipped with 16 double-flange track wheels which operate on rails at 30" centers. These wheels are compensated for longitudinal and transverse equalization which assures equal loading of all wheels. The rails being located over the web plates prevent flexing and cracking of top cover plate and reduces the number of diaphragms required.

This ladle crane trolley is equipped with a two-motor, synchronized worm drive, interlocked double-drum type main hoist. The synchronizing shaft employed in this scheme of gearing not only eliminates the undesirable ratchet gears but makes possible an additional safety feature in case one of the hoist motors fail. Under this condition both worms are driven by the remaining motor and all gearing functions as with two motors. In case of failure of one hoist motor on the conventional drive without the synchronizing shaft, hoisting is accomplished by only one set of gears. This imposes a double load on active gearing, the second drum being driven through the interlocking drum gears. The hoist gearing is so proportioned on all ladle cranes that the full capacity of the crane can be lifted by one motor without exceeding the quarter-hour rating.

The drum gears and pinions of the main hoist of this new crane have precision-cut, single-helical teeth, and in cooperation with the worm drive, assure vibrationless operation on either high or low speed hoisting and lowering.

All gears are fully enclosed and operate in a bath of oil, assuring long life and low maintenance.

This trolley is designed for maximum accessibility and ease of maintenance. Anti-friction bearings throughout.

The 4-part safety rope system installed on this crane affords the highest degree of safety in rope reeving.

Contact Alliance today. At your convenience a qualified engineer will discuss your heavy material handling problems. It's to your advantage.

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION

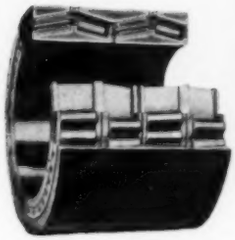
**THE**

**Alliance**

**MACHINE COMPANY**

*World's largest builders of world's largest cranes*

MAIN OFFICE
ALLIANCE, OHIO
PITTSBURGH OFFICE
1622 OLIVER BUILDING • PITTSBURGH, PA.



# no axe to grind

Since Torrington makes every basic type of anti-friction bearings, our engineers are able to make impartial recommendations for the type best suited to your needs.

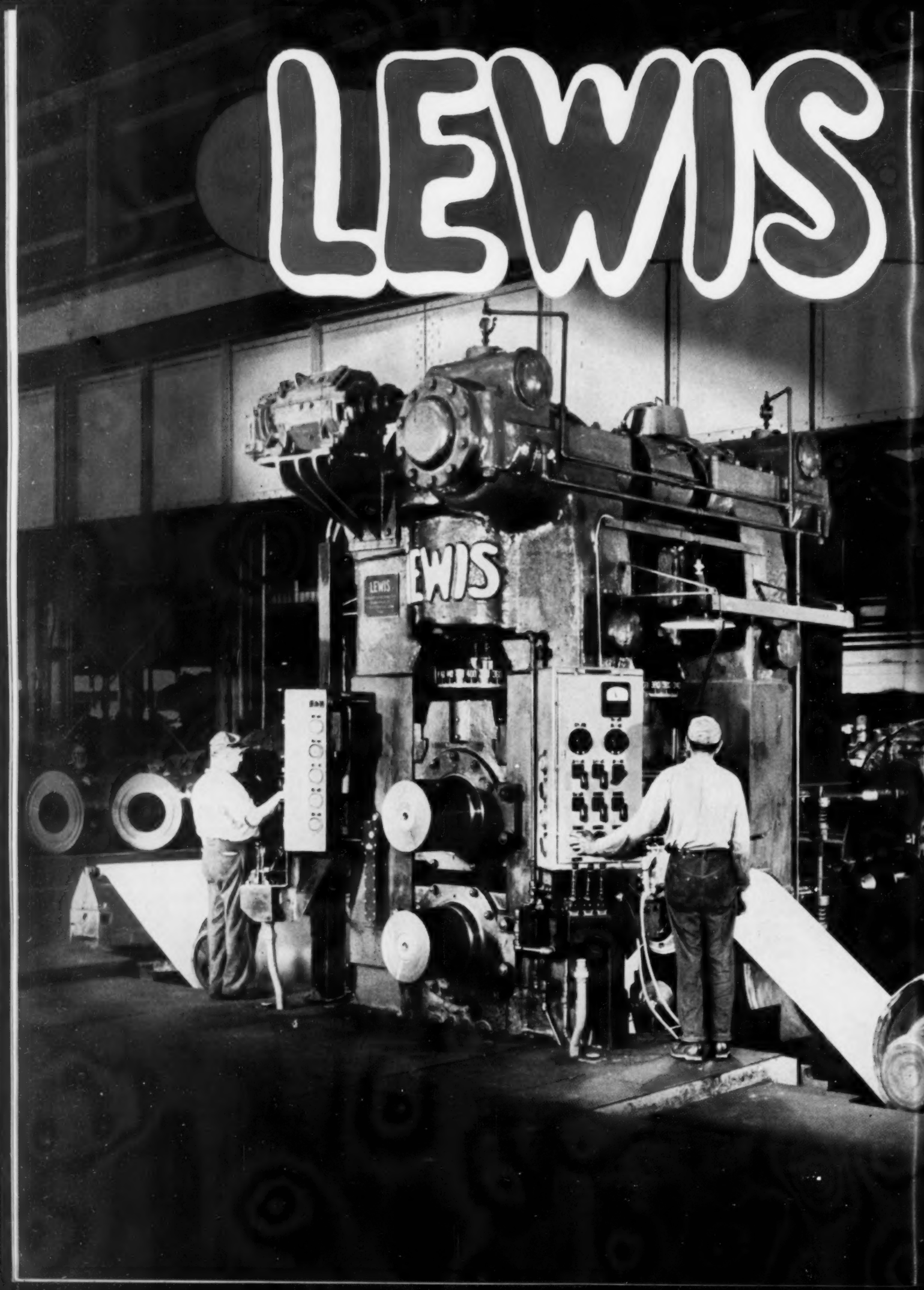
Perhaps your application calls for spherical roller bearings. Maybe tapered roller, straight roller, ball or needle bearings are what you need. Or, Torrington can design a special bearing, tailored to your requirements.

In short, whatever your friction problem, there's a Torrington bearing to solve it. Why not ask us to help you?

THE TORRINGTON COMPANY
South Bend 21, Ind. Torrington, Conn.
*District Offices and Distributors in Principal Cities of United States and Canada*

## TORRINGTON BEARINGS

**Spherical Roller • Tapered Roller • Straight Roller • Needle • Ball • Needle Rollers**


LEWIS
LEWIS
LEWIS

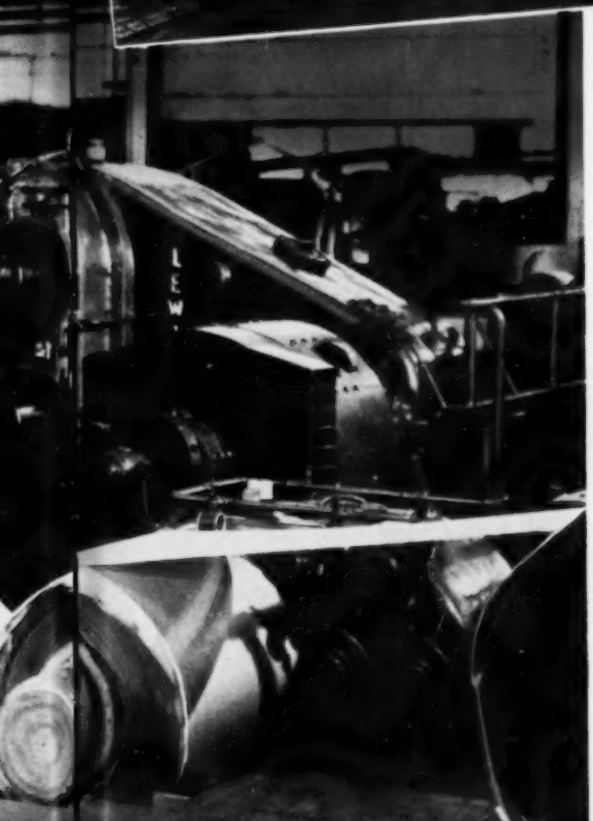
# ROLLING MILL EQUIPMENT....

A Lewis 28 x 42 inch two-high skin pass mill at the West Leechburg plant of Allegheny Ludlum Steel Corporation.

This mill will handle stainless steel strip in coils up to 60 inch diameter and 15,000 lb. weight.

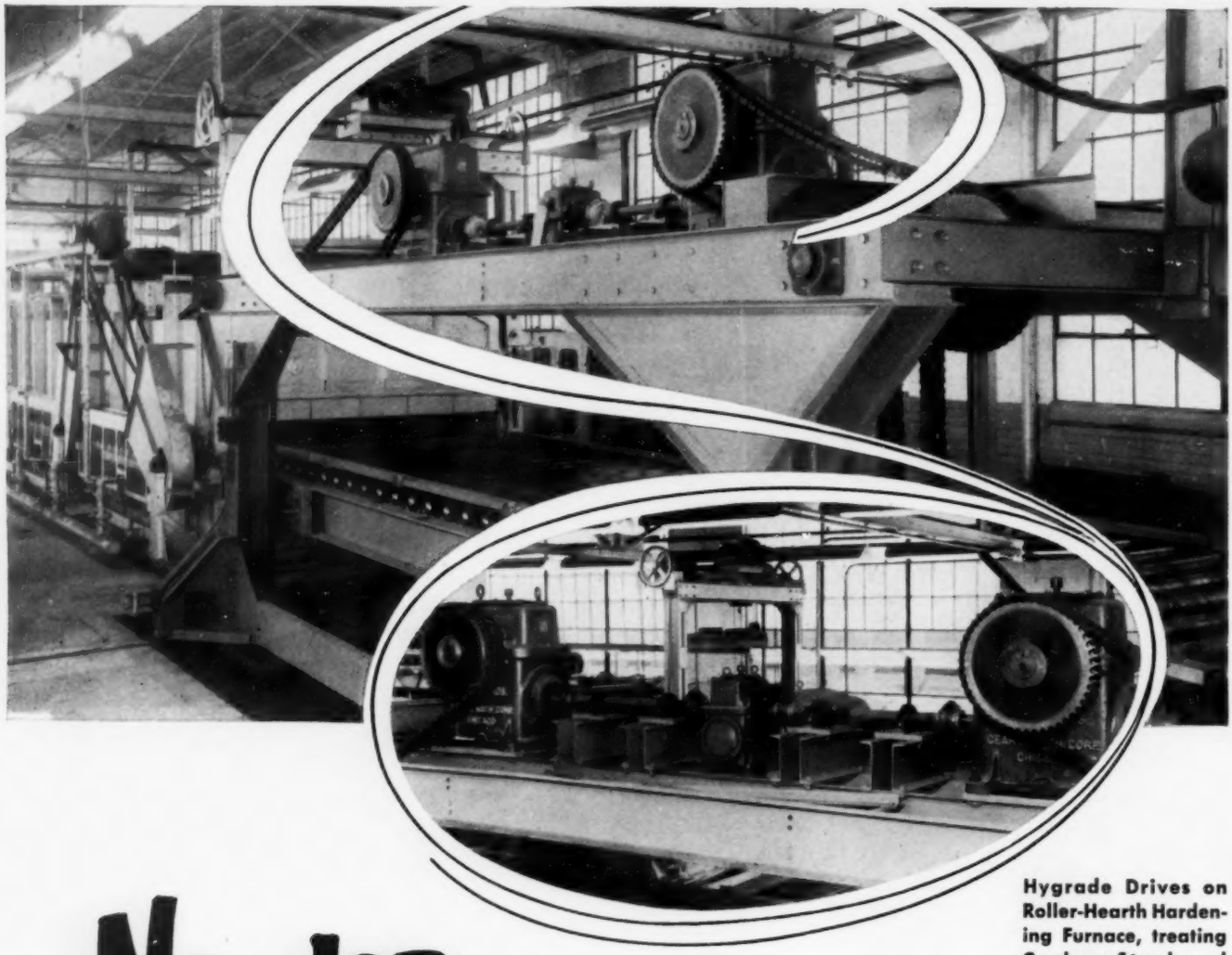
The mills are equipped with motorized screw-down, roller bearing rolls, Universal type spindles and motor-operated sled type roll changer.

This installation is typical of rolling mill equipment which Lewis furnishes the iron, steel and non-ferrous industries. Inquiries are always welcomed.



MANUFACTURERS OF
ROLLS AND ROLLING MILL EQUIPMENT
FOR THE IRON, STEEL AND
NON-FERROUS
INDUSTRIES

**LEWIS FOUNDRY & MACHINE**
**DIVISION OF BLAW-KNOX CO., PITTSBURGH, PA.**



Hygrade Drives on Roller-Hearth Hardening Furnace, treating Carbon Steel and Armor Plate, built by DREVER COMPANY, PHILADELPHIA.

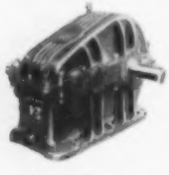
# NO JOB FOR A WEAKLING

Handling hot plate is no job for weaklings. This is why the Drever Company chose rugged, powerful Hygrade Drives on this Roller-Hearth Hardening Furnace. These sturdy units not only handle this tough job with ease, but with minimum maintenance.

Wherever you have a speed reduction problem where low cost and rugged dependability are essential, the Hygrade Line of Enclosed Worm Gear Drives offers a solution. Available in a wide range of ratios and h.p. capacities in horizontal and vertical types. Vertical drives are also available with wider low speed bearing span to accommodate long, unsupported output shaft extensions.

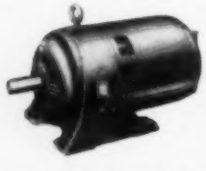
FOOTE BROS.

*Better Power Transmission Through Better Gears*



Maxi-Power Drives

Line-O-Power Drives



Foote Bros.-Louis Allis Gearmotors

Foote Bros. Gear and Machine Corporation
Dept. IAS, 4545 South Western Boulevard
Chicago 9, Illinois

Please send a free copy of Bulletin HGB on Foote Bros. Hygrade Worm Gear Drives.

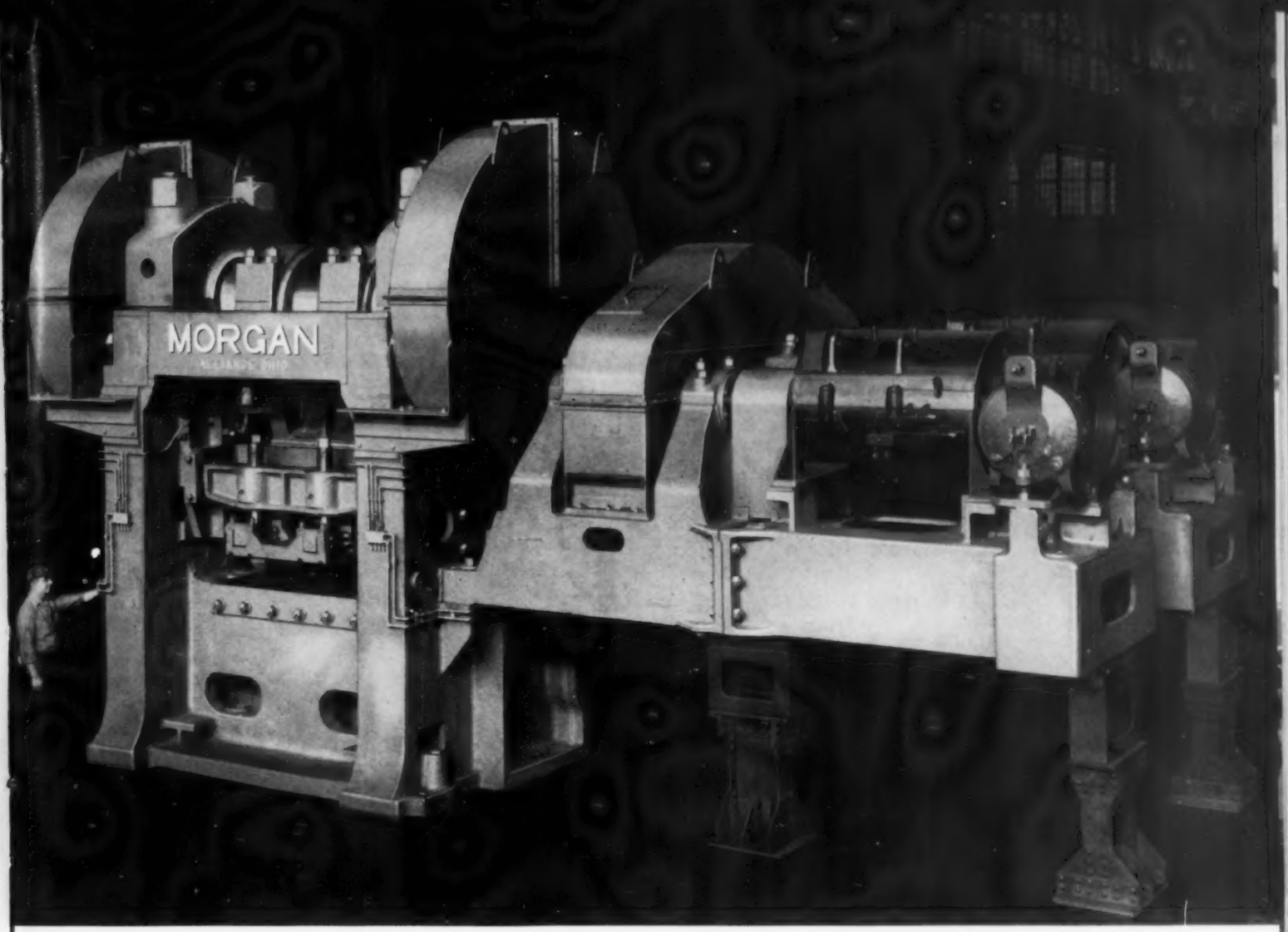
Name.....

Company.....

Position.....

Address.....

City.....Zone.....State.....




## 1200-TON DOWN CUT SLAB SHEAR

BUILT BY MORGAN Engineering

DESIGNERS • MANUFACTURERS • CONTRACTORS

BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS

ELECTRIC TRAVELING CRANES • CHARGING MACHINES

INGOT STRIPPING MACHINES • SOAKING PIT CRANES

ELECTRIC WELDED FABRICATION • LADLE CRANES

STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES

SPECIAL MACHINERY FOR STEEL MILLS

**THE MORGAN ENGINEERING CO.**

ALLIANCE, OHIO PITTSBURGH—1420 OLIVER BUILDING

Illustrated is a 1200-ton hot Slab Shear of the start-stop type with twin-motor drive.

Shear has a 12″ stroke. Designed to cut maximum 51″ wide x 6″ thick stainless steel and 60″ wide x 7″ thick carbon steel slabs.

Cutting speed eight (8) strokes per minute.

*Your inquiries for mill equipment will be appreciated.*

# IT'S THE *Built-in Quality* THAT COUNTS!

*Designed to fit your present resistor space*

**STEEL GRID RESISTORS**
**consistently prove their value in**
**STEEL MILL SERVICE**

*Write for Bulletin No. 500*

By use of those durable raw materials . . . steel and mica, and the P-G exclusive features of design, these Steel Grid Resistors have the "built-in quality" to overcome factors which often cause resistor failures. Vibration, moisture laden or corrosive atmospheres have little effect on continuity of service. Try Post-Glover Resistors for heavy duty applications where resistors are subject to severe service . . . continuous "Trouble-Free" performance is assured.

P-G

*The Nonbreakable Steel Grid Resistor*

**THE POST-GLOVER ELECTRIC COMPANY**

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

4-HIGH REVERSING COLD MILL

*Designed and built by*

# UNITED

## ENGINEERING AND FOUNDRY COMPANY

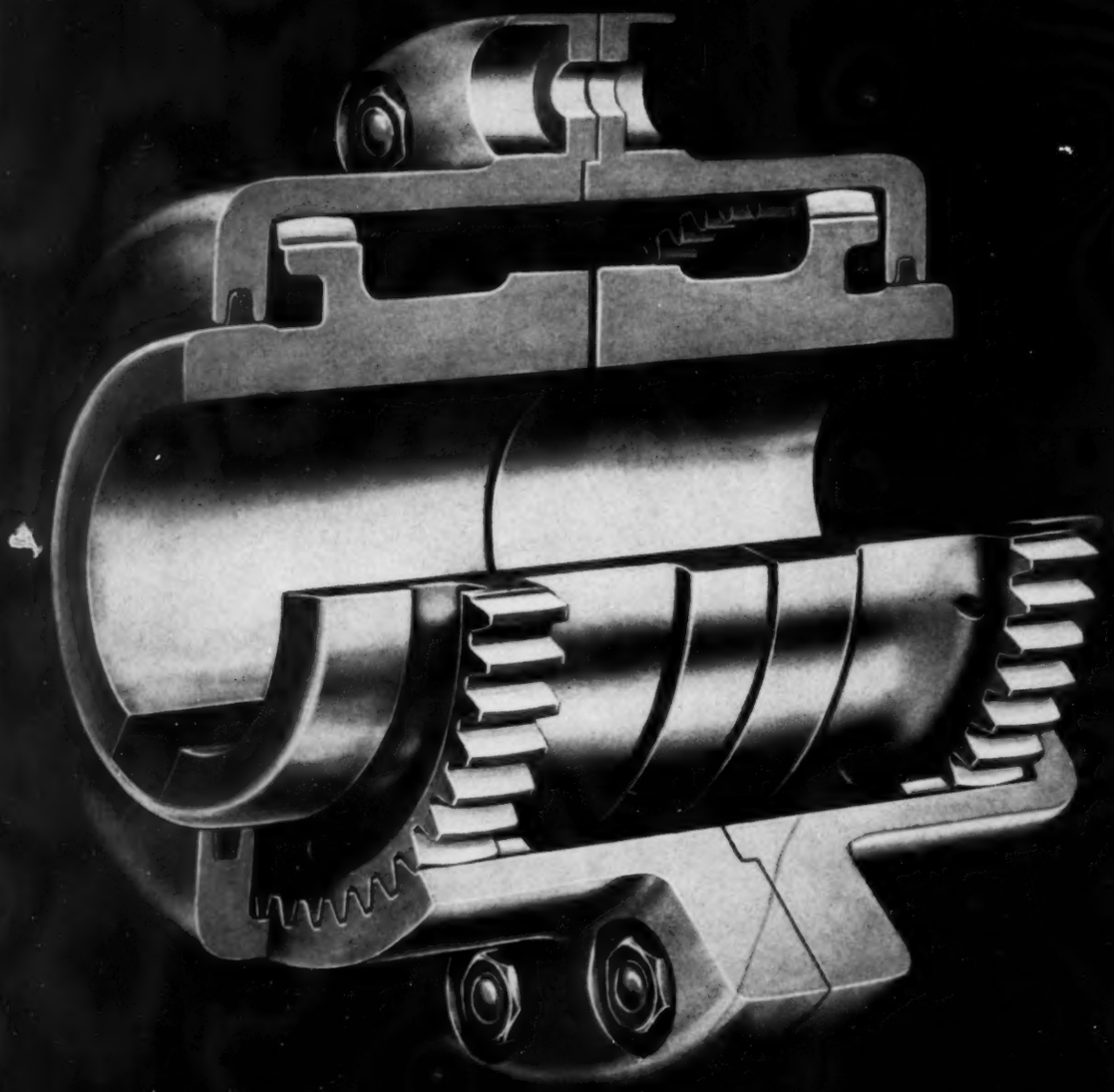
PITTSBURGH, PENNSYLVANIA

Plants at: PITTSBURGH • VANDERGRIFT . NEW CASTLE • YOUNGSTOWN • CANTON

Subsidiaries: ADAMSON UNITED COMPANY, AKRON, OHIO • LOBDELL UNITED COMPANY, WILMINGTON, DELAWARE • STEDMAN FOUNDRY AND MACHINE CO., INC., AURORA, INDIANA

*Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other Heavy Machinery. Manufacturers of Iron, Nodular Iron and Steel Castings, and Weldments.*

# POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

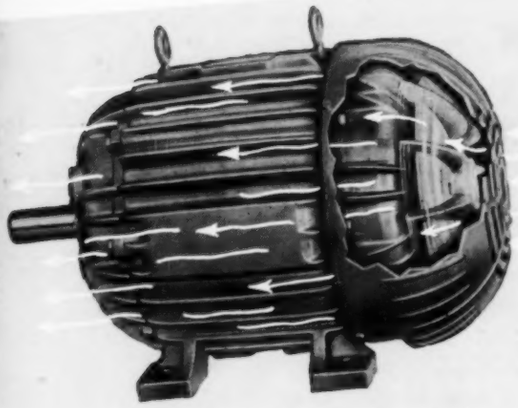
# FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

# ELLIOTT Crocker-Wheeler
# 600 SERIES MILL MOTOR

■ Concentrated toughness is built into this motor. Not only will it stand the gaff of constant, heavy service, but due to superior engineering, it packs as much as 1/3 more power in each standard size frame. Split frame allows quick access to bearings, armature, field coils. From 5 to 265 hp. Also available *separately forced-ventilated, protected self-ventilated, back-geared.* Write for the Mill Motor Bulletin.



**Popular for 11 Years!**
**ELLIOTT CROCKER-WHEELER SEALEDPOWER MOTOR**

This totally enclosed fan-cooled induction motor keeps cool with a cowl-directed blast of air driven along its finned case. This air-stream carries off heat, and says "no parking" to dirt, dust, lint, etc. In 3 to 125 hp. Also available in vertical type, and in explosion-proof, underwriters approved, in most ratings. Ask for the Sealedpower Bulletin.

## ELLIOTT Company

**CROCKER-WHEELER DIVISION**
**AMPERE, N. J.**

*For large motors:* RIDGWAY DIV., RIDGWAY, PA.
*Plants at:* JEANNETTE, PA. • RIDGWAY, PA. • AMPERE, N. J.
SPRINGFIELD, O. • NEWARK, N. J.
*BRANCH OFFICES AND REPRESENTATIVES IN PRINCIPAL CITIES*
*ELLIOTT APPROVED SERVICE SHOPS COVER THE COUNTRY*

W2-11

Case History No. 106

## Rolling Mill Screwdown

# 9/10 LESS Lubricant Used

THE I.P. LUBRICANT

with "Indestructible pH-ilm" capable of withstanding pressures up to 50,000 psi.

## With BROOKS

# LEADOLENE

On each eight hour shift in a large eastern steel plant 30 gallons of good quality steam cylinder oil were used on each of the two screws of a modern slabbing mill. Then LEADOLENE was thoroughly tested, and the tabulated results showed that only 3 gallons per eight hour shift were used on each screw . . . a savings of 9/10 on lubricant consumption. In addition, operating temperature of the screws was reduced from 210° F to 140° F.

On rolling mill screwdowns, the most difficult of all screws to lubricate, LEADOLENE consistently has reduced lubrication consumption and extended equipment service life. With its "Indestructible pH-ilm," plus high adhesiveness, exceptional temperature characteristics, and low pour point and viscosity, LEADOLENE gives superior service on all types of screws used to move apparatus . . . whether open or enclosed, horizontal, vertical, inclined, high or low speed.

*Write for technical data or generous samples for your testing.*

**With LEADOLENE You Get These Characteristics Essential to Good Screwdown Lubrication**

**pH-ilm Strength** . . . 50,000 psi minimum.

**Adhesiveness** . . . Affinity for metal develops maximum adhesion and reduces dripping and creeping.

**Water Repellence** . . . Effectiveness is not reduced by water.

**Corrosion Prevention** . . . Never acidic and will not etch or corrode.

**Compounded Stability** . . . Will not bleed or change physical condition within a greater temperature range.

**Low Temperature Factors** . . . Does not harden, crack or decrease in adhesion.

**Abrasive Resistance** . . . Repellent to adhesion of scale, metallics and other contamination.

*The Brooks Oil Co.*

Since 1876

Executive Offices and Plant . . . CLEVELAND, OHIO
Executive Sales Offices . . . PITTSBURGH, PA.
Canadian Offices and Plant . . . HAMILTON, ONTARIO
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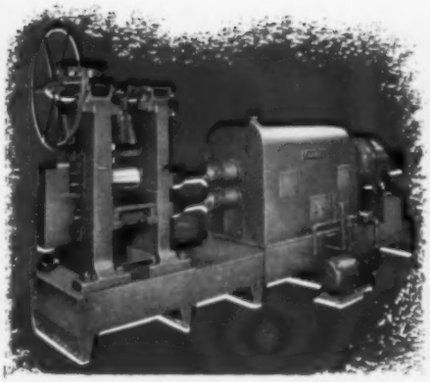
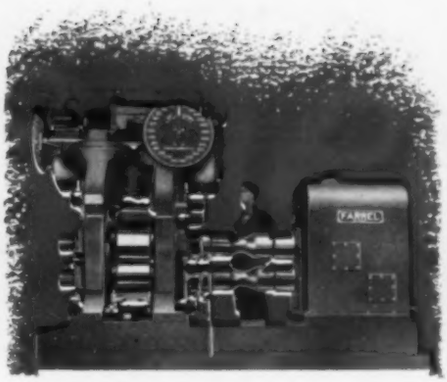
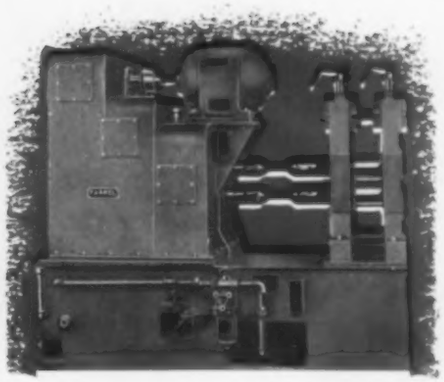


Designed for laboratory experimental work, this 8" x 12" mill was supplied with two sets of rolls, one pair having smooth faces and the other grooved. Both sets of rolls are chilled iron and are bored for the insertion of electric-cartridge heating units.



10" x 10" mill specially designed for close gauge control in continuous high-speed, cold rolling of high-carbon strip steel. High-powered screwdown permits adjusting gauge under full load. Screws can be adjusted independently or in synchronism through magnetic clutches.



6" x 6" mill equally adaptable to specialized production work or to laboratory testing. The unit is completely self-contained, with mill, combined reduction drive and pinion stand, and motor mounted on a common bedplate. A safety interlock prevents operation if the lubrication system is not functioning.

# Looking for a Rolling Mill for Laboratory or Specialized Production?

## ONE OF THESE MAY GIVE YOU AN IDEA

Each of the mills pictured on this page was designed by us with the special requirements of the individual customer in mind. They are efficient and economical solutions of specific problems.

You, too, can obtain similar assistance — in the form of a mill which will meet your needs exactly. Simply tell us your requirements or, if you prefer, one of our engineers will be glad to discuss your problems with you.

Farrel mills are built in a wide range of types and sizes for rolling nonferrous rods, strips or sheets, metal foils and cold strip steel. We also design and manufacture coilers and special handling equipment required to make each installation a complete, efficient unit.

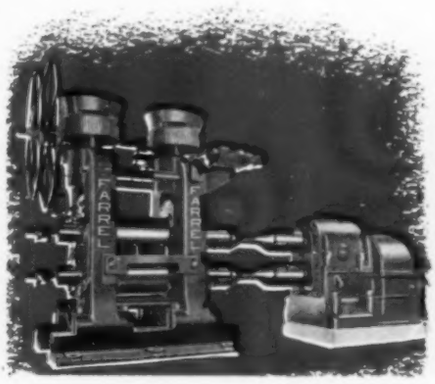
**FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.**

*Plants:* Ansonia and Derby, Conn., Buffalo, N. Y.

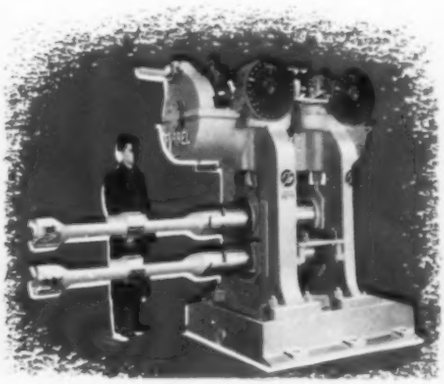
*Sales Offices:* Ansonia, Buffalo, New York, Akron, Pittsburgh, Chicago, Los Angeles, Houston

*Farrel-Birmingham*®

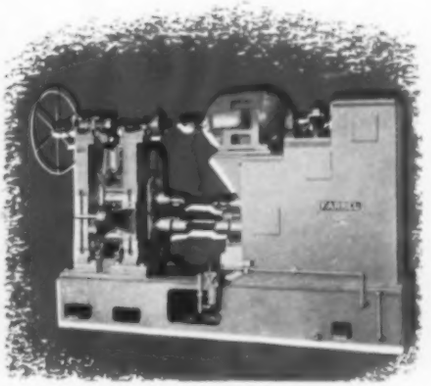
FB-782



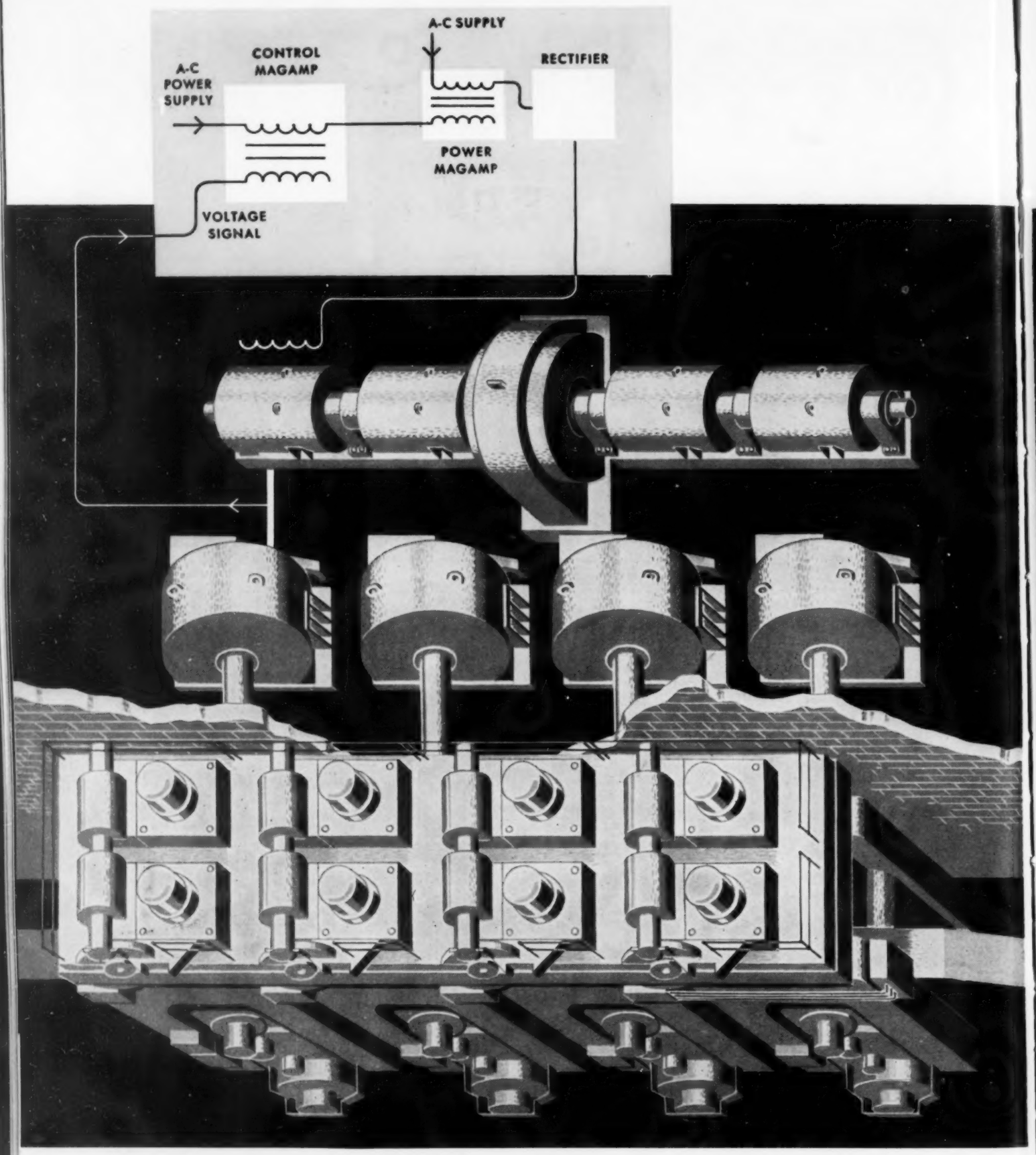
16" x 24" mill designed for research on metals and alloys. The mill, which takes four-inch ingots or plate, is equipped for both cold and hot rolling. Rolls can be internally steam heated to permit rolling in a temperature range of 400° to 600°F.



12" x 14" laboratory mill with provision for spreading the housings to take 24" face rolls for rod production. The mill is of very sturdy construction, has motor-operated screwdown and the top roll is hydraulically counterbalanced. Variable-voltage drive permits speed range of 10:1.

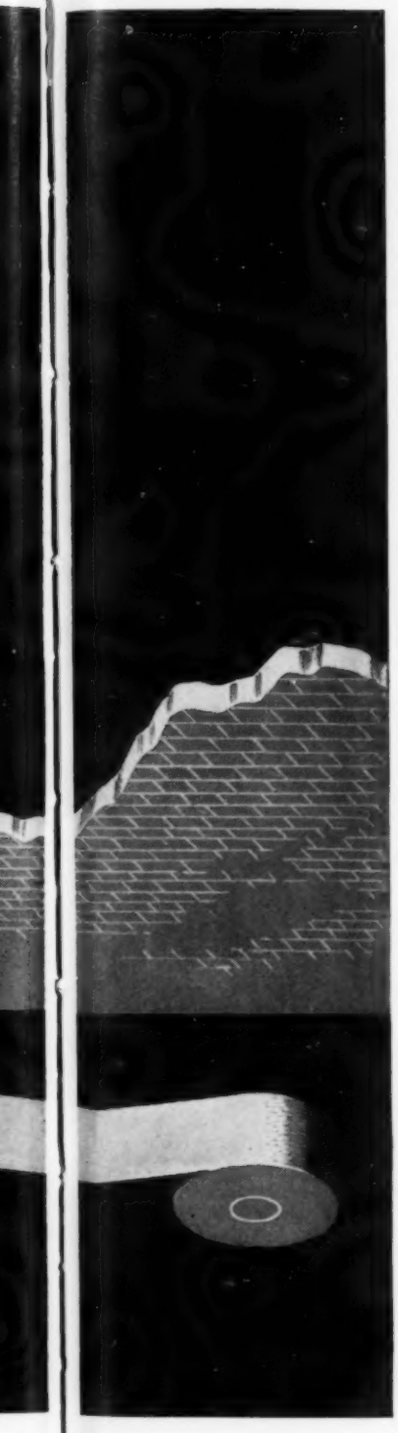


8" x 10" strip-finishing mill mounted on fabricated base with combined drive and pinion stand. Forged-steel rolls are equipped with buffs. Top roll has spring-type counterbalance arrangement and handwheel adjustment. Bracket and bar act as letoff; windup is friction type.




***Simplified Diagram Above*** shows the Magamp control for one stand of a tandem mill. All stands are regulated by matching the drives to a common reference bus. Stand speed is set by generator voltage. If it varies from reference voltage, the differential is fed into Magamp and there it is amplified. This large output current is rectified to d-c and fed into the generator field. The change in field strength then restores the motor speed to its correct value.

# A major new development for steel mill drives



## WESTINGHOUSE MAGAMP REGULATOR

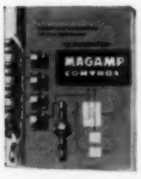
Here's a new drive regulating device with important possibilities for your mill. It's the Westinghouse Magamp®, a new application of the magnetic amplifier. Thoroughly tested on all kinds of mill and process drives, Magamp is ready now to help you increase production.

Below, a few reasons why Magamp has become a major regulating method:

1. Magamp acts fast—and it's highly accurate. On tandem cold-reduction mills, on hot strip mills, on rod and merchant mills, Magamp's speed means rapid response to sudden changes. Acceleration and deceleration are fast and even.
2. Magamp corrects without overshooting. It hits the right point and holds it. On reel control systems Magamp keeps tension constant as the coil builds up. On process lines—slitting, shearing, cleaning, pickling—Magamp precisely controls tension, voltage and speed under running conditions.
3. Magamp has no moving parts—no brushes, no bearings, no tubes to burn out. Because it's a simple static circuit, Magamp holds its settings. Maintenance is almost nonexistent.
4. Magamp is easy to install. Units are panel mounted and factory wired. No bedplate, no extra conduit, Magamp needs no warm-up. Flip the switch and it's ready to go.

### *CALL WESTINGHOUSE EARLY ON YOUR NEXT PROJECT*

Magamp is another in Westinghouse's long line of solid achievements for steel mills. When you're planning a drive—or any other steel mill project—get in touch early with your nearby Westinghouse Office. J-94909




### *LEARN MORE ABOUT MAGAMP*

Write us for this new free booklet about the Magamp Regulating System. You'll profit from the description, pictures and diagrams on how Magamp works—and can work in your mill. Ask for "The Westinghouse MAGAMP REGULATOR"—B-5468. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania.

YOU CAN BE SURE...IF IT'S

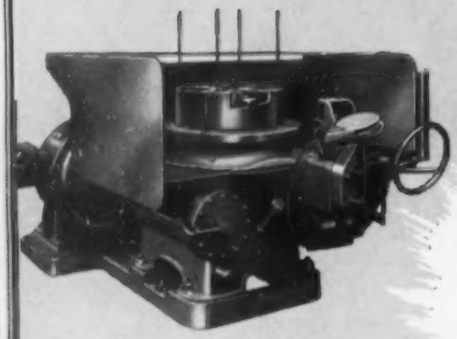
**Westinghouse**

***MATCHED EQUIPMENT FOR STEEL PRODUCTION***

**FOR THE *MATERIAL* YOU DRAW—**

**FOR THE *SIZES* YOU REQUIRE—**

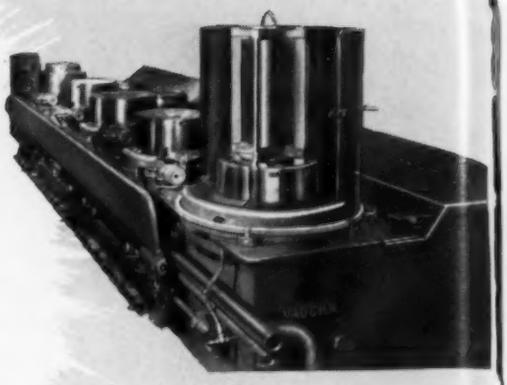
**FOR THE *TONNAGE* YOU WANT—**



MOTOBLOC®

# Vaughn®

**has the *RIGHT* EQUIPMENT to handle the job!**



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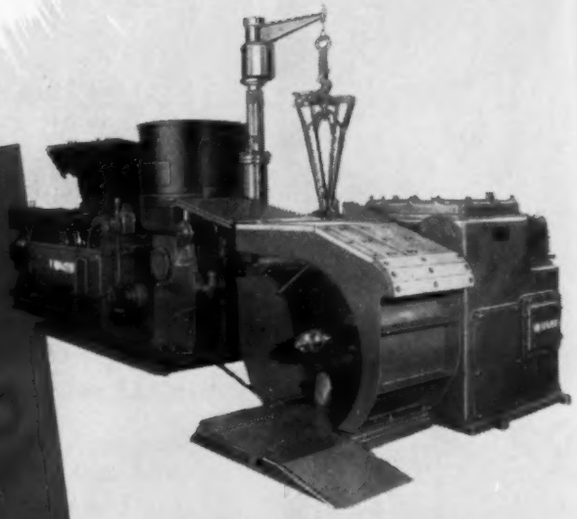


CONTINUOUS MACHINES

"Quick on the Draw!"

**VAUGHN COLD DRAWING EQUIPMENT**

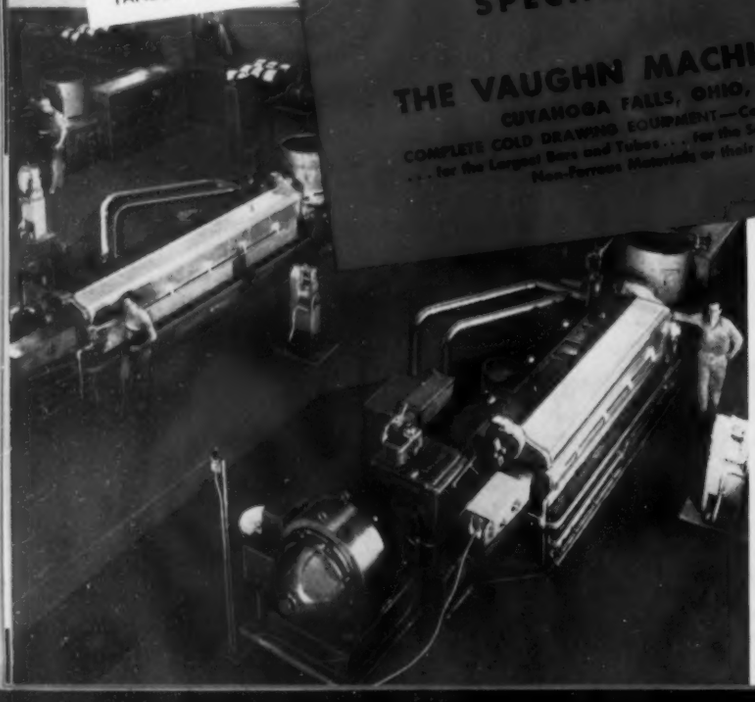
WIRE • BARS • TUBES
SPECIAL SHAPES

**THE VAUGHN MACHINERY CO.**

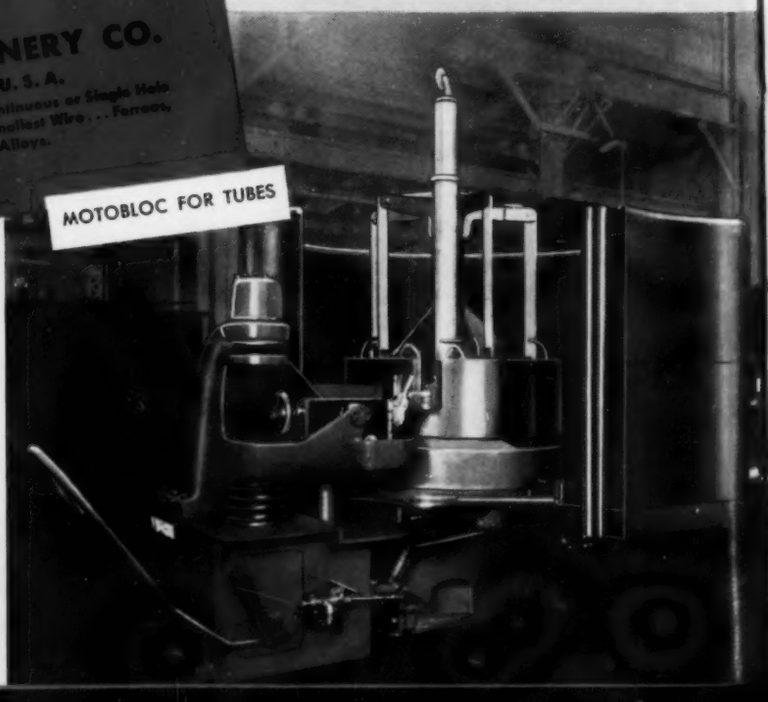
CUYAHOGA FALLS, OHIO, U. S. A.

COMPLETE COLD DRAWING EQUIPMENT—Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

TANDEM MACHINES



MOTOBLOC FOR TUBES



Stopping Rust with RUST-OLEUM 769 D.P. Red Primer

# RUST-OLEUM

Look for this label. Be sure it's genuine RUST-OLEUM!

**All Colors, Aluminum and White—**
**Beautifies As It Protects!**

This practical coating may be applied directly over surfaces already rusted without removing all the rust! Simply wirebrush and use sharp scrapers to remove rust scale and loose particles . . . sandblasting and chemical pre-cleaning are not usually required. Easy to apply by brush, dip, or spray . . . dries to a firm, pliable coating. Cut your maintenance costs, save metal — with RUST-OLEUM! Prompt delivery from Industrial Distributor stocks in principal cities.

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**FREE SURVEY:** A RUST-OLEUM specialist will gladly survey your rust problems. He'll make specific tests and recommendations. No cost or obligation. See Sweets for complete catalog and nearest RUST-OLEUM distributor, or write for literature on your company letterhead.

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# NOW—

## Keystone ALUMINUM Conductor System for all Applications

### A NEW, COMPLETE SYSTEM OFFERING HIGH CURRENT CAPACITY AND LOW IMPEDANCE

Keystone introduces a new development—an aluminum conductor (third rail) system. In addition to conserving critical copper and steel, it offers industrial users many important operating and structural advantages. Here is a complete sliding contact system which is pre-engineered, efficient and compact in design, yet constructed for years of service. It has high current-carrying capacity . . . up to 1,000 amperes . . . with a small cross-sectional area.

Non-magnetic, the new Keystone Aluminum third rail system provides good voltage regulation for alternating current because of its low impedance. It offers new economies because it is easier to install, requires less manpower and eliminates the need for high-cost supporting structures.

It is designed for such applications as main crane runways, bridge conductors, hydro-electric dams and numerous other jobs.

If you have a collector problem or plan a new installation replacement of an old system, consult our engineering specialists.

**OPERATIONAL FEATURES**

- Requires less space
- Operates under conditions unfavorable to other metals
- Easy maintenance
- Pre-engineered components for easy assembly.

**Write today for new, illustrated 4-page folder on Keystone Aluminum Conductor System.**

## ELECTRIC SERVICE MANUFACTURING CO.

PHILADELPHIA 32, PENNA.

*Represented in Canada by* Lyman Tube and Bearing, Ltd., Montreal and Toronto

# FARRELL-CHEEK

## HARD EDGE WHEELS

**LONGER SERVICE ON THE JOB**

**ALWAYS MORE ECONOMICAL**

**Finest Name in Cast Steel!**

## FARRELL-CHEEK STEEL CO.

**MANUFACTURERS OF HIGHEST QUALITY ELECTRIC FURNACE CARBON AND ALLOY STEEL CASTINGS**

**FARRELL'S CARBON STEEL CASTINGS**
**FARRELL'S HARD EDGE STEEL CASTINGS**
**FARRELL'S "BS" STEEL CASTINGS**

**RAILROAD CASTINGS**
Locomotive and Car
R. R. Specialty Castings.

**ELEVATOR, CONVEYOR PARTS**
Sprockets, Traction Wheels, Chains, Buckets, Rollers, Idlers.

**BUSHINGS**
Carbon and Alloy Steels Machined, Hardened, Ground.

**CRANE WHEELS**
Overhead, Gantry, Monorail, Ingot Car, Charging Machine.

**GEARS AND PINIONS**
"True Tooth" Gears and Pinions, Sheaves and Wheels.

**SPECIALIZED CASTINGS**
Light Section Castings.

**STOKER PARTS**
Feed Screws, Furnace Tools, Flanged Pipe, etc.

**HEAVY HARDWARE**
Wire Rope Fittings, Choker Hooks, Bar Benders, Cutters.

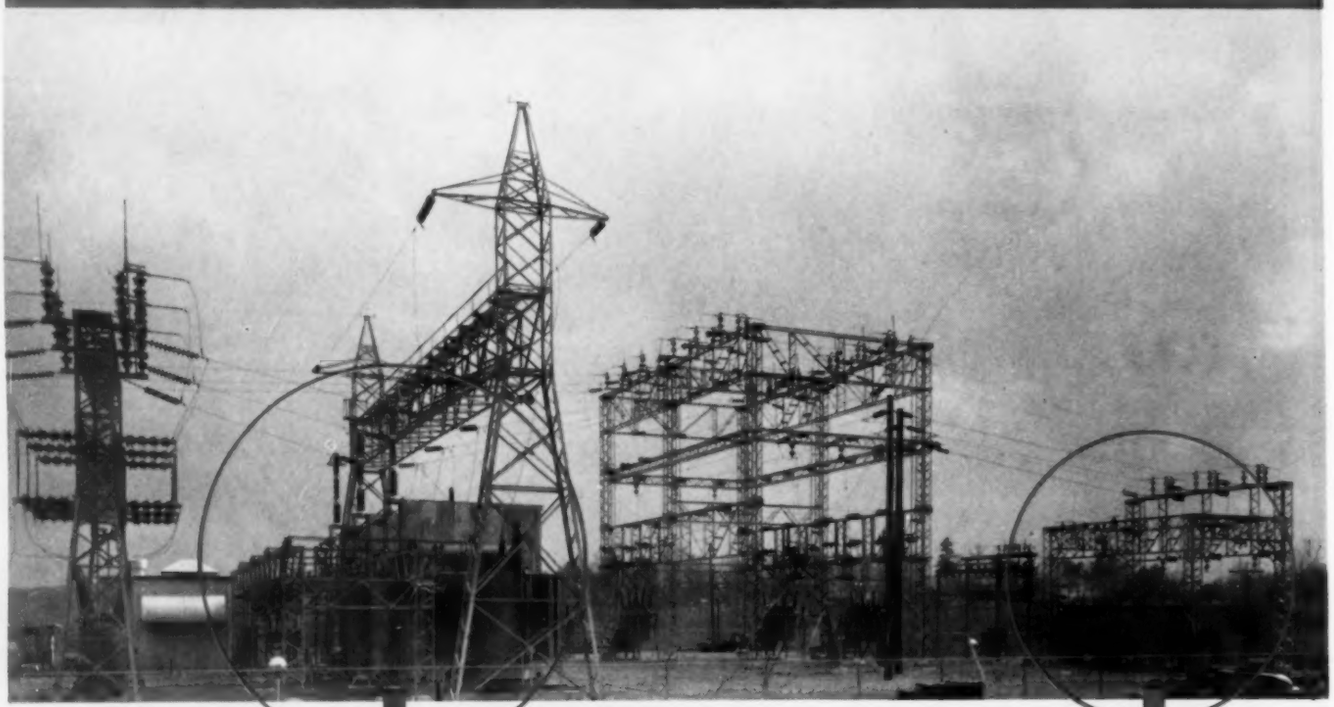
**YOUR INQUIRY WILL PROMPTLY BRING DETAILED INFORMATION PERTAINING TO ANY OF THE ABOVE FARRELL-CHEEK PRODUCTS**

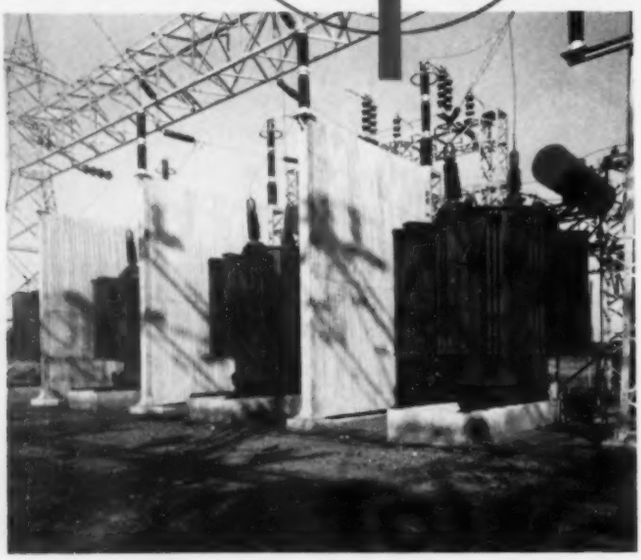
**• • • SANDUSKY, OHIO U.S.A.**

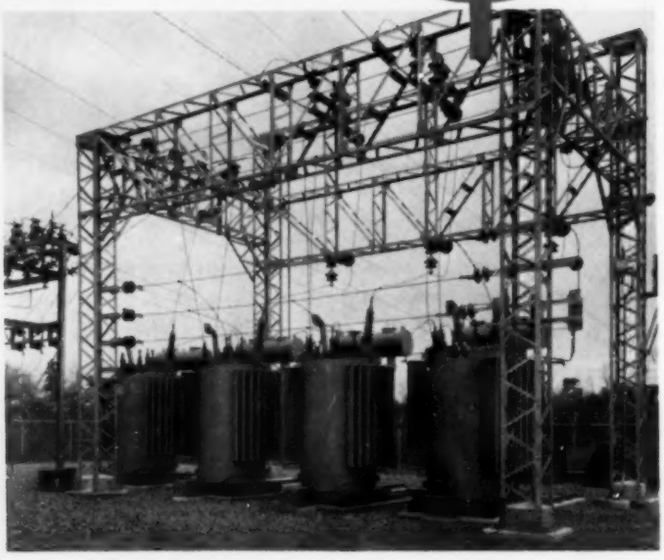
# *Pennsylvania*

## an important component of many

**ALTAVISTA SUBSTATION** Virginia Electric & Power Company







# TRANSFORMERS . . .
# "Selected" Outdoor Substations

There is only one positive way of combining the finest equipment into an outdoor substation, and that is by careful selection of all component parts.

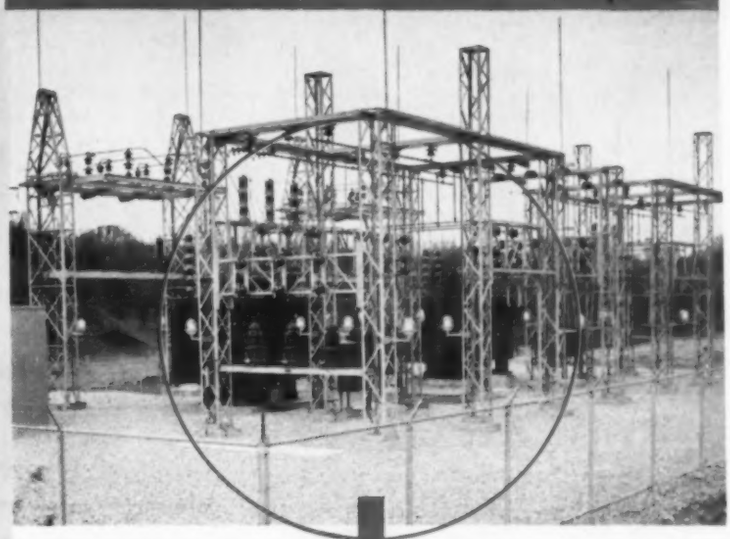
Only by carefully selecting transformers, switchgear, breakers, etc., can the engineers of an Electric Utility be sure that all items of the station will meet the prescribed mechanical and electrical requirements. And *only* by selective ordering can the Utility get what it actually *wants* and *needs.*

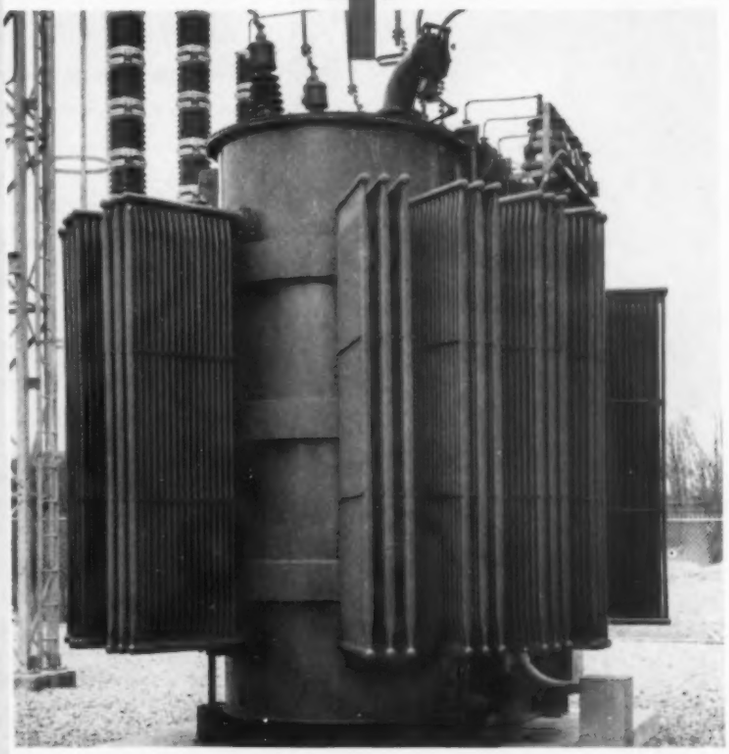
Pennsylvania transformers are an important component in many outstanding outdoor substations. The Midway Station of the Cincinnati Gas & Electric Company and the Altavista Transmission Substation of Virginia Electric Light and Power Company are examples of two modern stations in which the component transformers were supplied by Pennsylvania Transformer Company.

•

*Pennsylvania Power Transformers are available in sizes up to 100,000 Kva, and voltages up to 230 Kv. Transformers with ratings of 60,000, 70,000, and 100,000 Kva are now under construction in the Pennsylvania plant.*

**MIDWAY SUBSTATION** Cincinnati Gas & Electric Company

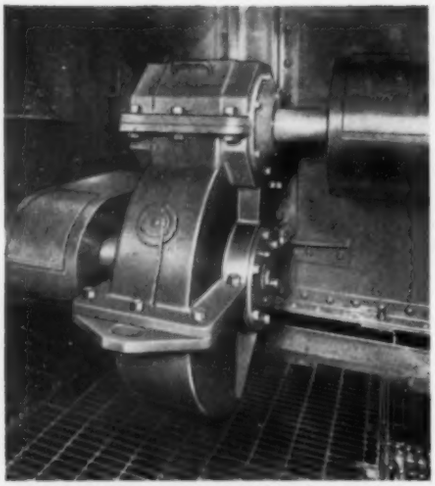




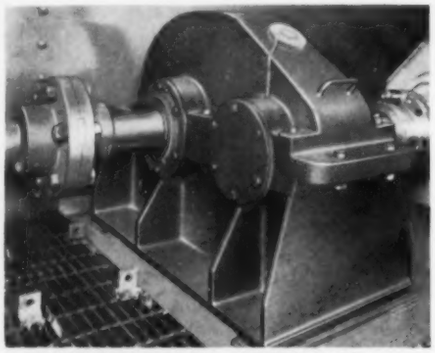
## NOTICE TO ELECTRIC UTILITIES

You are invited to inspect the plant and facilities of Pennsylvania Transformer Company. Arrangements can be made through a Pennsylvania sales representative, or by contacting Pennsylvania's Sales Department, 529 Adams Avenue, Canonsburg, Pa.

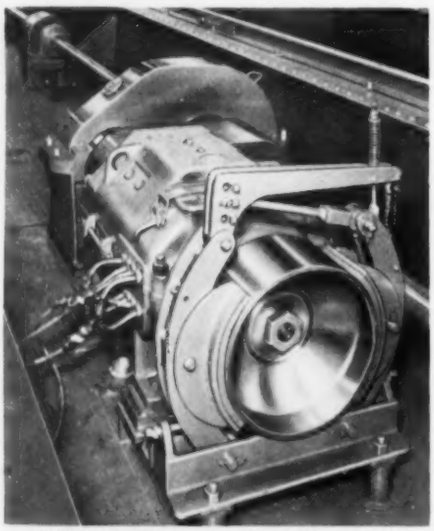
**Pennsylvania**
**TRANSFORMER COMPANY**
**CANONSBURG, PENNA.**
***Greater Pittsburgh District***



***BRIDGE DRIVE END ASSEMBLY*** has straight and tapered roller bearings, horizontally split gear cases.



***BRIDGE DRIVE CENTER ASSEMBLY*** with connection utilizing face keyed flange couplings to take shear from bolts.



***BRIDGE MOTOR and HYDRAULIC BRAKE*** and self-aligning cross shaft bearings for ease of maintenance.

# CRANES FOR THE STEEL MILL . . . TO A.I.S.E. SPECIFICATIONS

**Representative of the many Steel Mill Cranes "Shaw-Box" has developed and built to the new A.I.S.E. specifications is this 15-ton capacity 61' 8" span single hook crane with single A-5 drive, auxiliary braced girders, rigid end ties, and landing platform in rear to provide complete operator visibility.**

**In addition to the features pictured at the left, "Shaw-Box" A.I.S.E. Crane Bridges offer outstanding advantages such as Timken-Rollway wheel bearing assemblies and all shafting designed with one thrust and one straight roller bearing at each end. Trolley construction includes totally decked and toeboarded frames with oil-tight gear cases and pedestal bearings built integrally in them, sheave supports mounted above the frames with sheave assemblies removable as units, and accessibility of all parts for easiest maintenance.**

**In each are the most advanced engineering and production techniques making possible the high efficiency, low-operating costs, and exceptional maintenance convenience for which "Shaw-Box" Cranes are so well known.**

**For the popular sizes and types of mill cranes, together with the different variable optional units preferred by individual mills, "Shaw-Box" already has A.I.S.E. specification designs. "Shaw-Box" Cranes, built to A.I.S.E. specifications to meet specific applications, are readily available and attractively priced.**

***BE SURE TO SEND ALL YOUR INQUIRIES FOR STEEL MILL CRANES AND SOAKING PIT CARRIAGES TO "SHAW-BOX"***

## "Shaw-Box" CRANES

MANNING, MAXWELL & MOORE, INC.

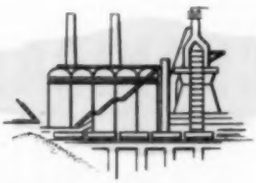
Muskegon, Michigan

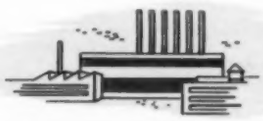
Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, and 'American' Industrial Instruments.

# Producers of IRON and STEEL the world over

*use*
*the Specialized*
*Engineering Service of*

## THE BRASSERT CORPORATION





**This experienced organization designs, constructs and places in operation:**

- ★ **Blast Furnaces**
- ★ **Open Hearth Furnaces**
- ★ **Bessemer Furnaces**
- ★ **All Types of Ordnance Furnaces**
- ★ **Soaking Pits**
- ★ **All Types of Heating, Reheating and Annealing Furnaces**

## The BRASSERT Corporation

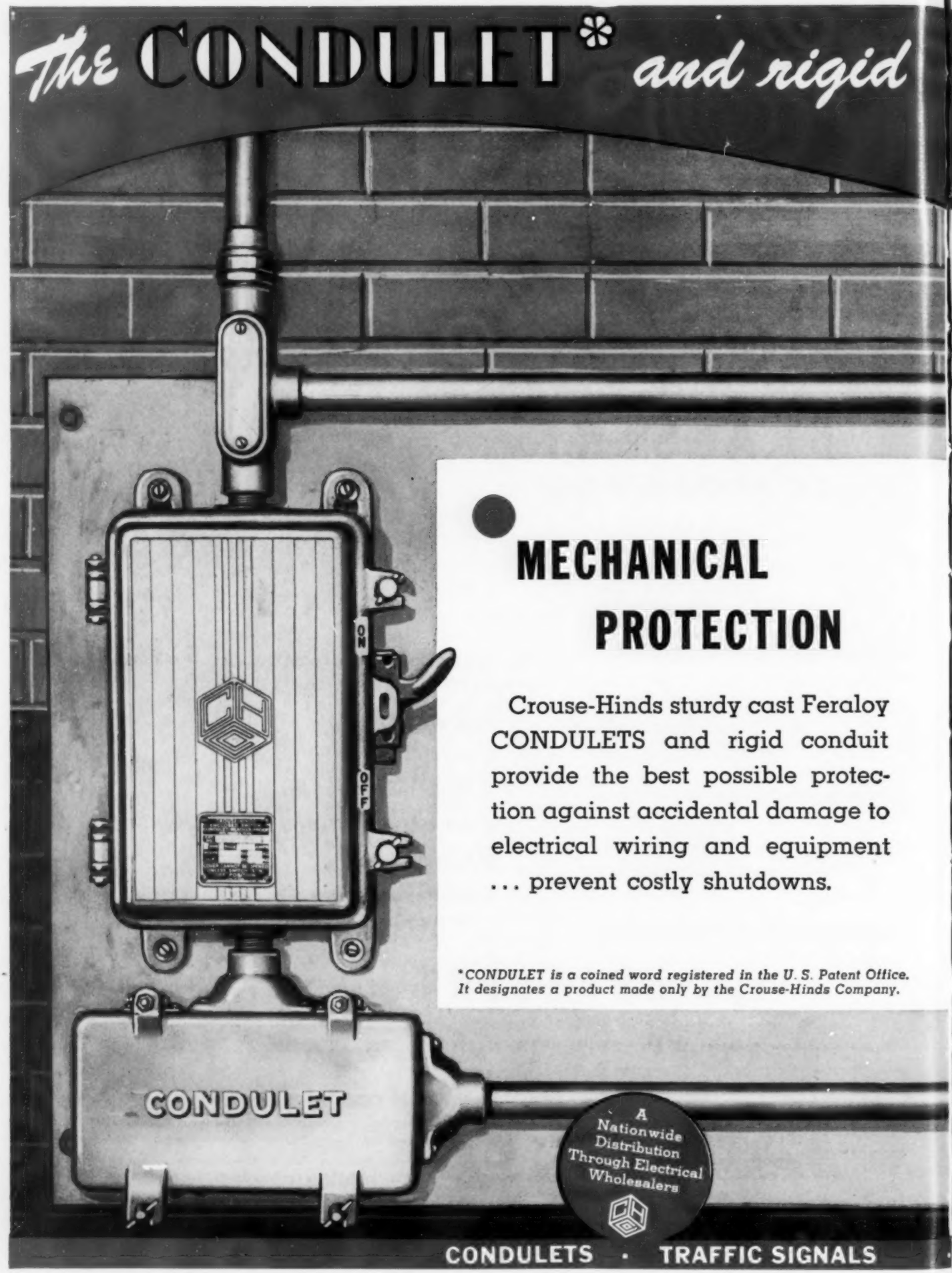
*C. A. BRASSERT, President*

**210 BOULEVARD OF THE ALLIES PITTSBURGH 22, PENNA.**

**PARTIAL LIST BRASSERT CLIENTS**

**United States Steel Company • National Tube Division • Republic Steel Corporation • Jones & Laughlin Steel Corp. • Bethlehem Steel Co. • Inland Steel Company • Detroit Steel Corporation • Portsmouth Steel Company • Weirton Steel Company • National Steel Corporation • Societa Italiana Ernesto Breda (Breda), *Italy* • Government of Western Australia, *Australia* • Solel Boneh, Ltd., *Israel* • Vereinigte Oesterreichische Eisen und Stahlwerke Aktiengesellschaft (VOEST), *Austria* • Societe Anonyme D'Ougree Marihaye, *Belgium* • Royal Dutch Iron & Steel Works, *Holland* • Westfalenhuette Dortmund, A.G. (Westfalenhuette), *Germany* • Corporacion de Fomento de la Produccion (Fomento), *Chile* • Cia. Acos Especiais Itabira (Acesita), *Brazil* • Generalna Direkcija Crne Metalurgije (GDCM), *Yugoslavia***

# The CONDULET* and rigid




## MECHANICAL PROTECTION

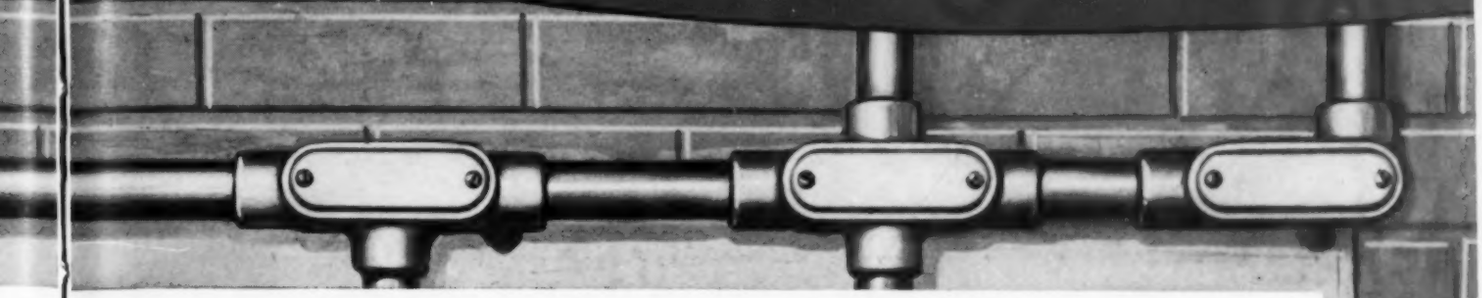
Crouse-Hinds sturdy cast Feraloy CONDULETS and rigid conduit provide the best possible protection against accidental damage to electrical wiring and equipment ... prevent costly shutdowns.

*CONDULET is a coined word registered in the U. S. Patent Office. It designates a product made only by the Crouse-Hinds Company.

A Nationwide Distribution Through Electrical Wholesalers

CONDULETS · TRAFFIC SIGNALS

# conduit method gives you MAXIMUM PROTECTION to wiring and equipment



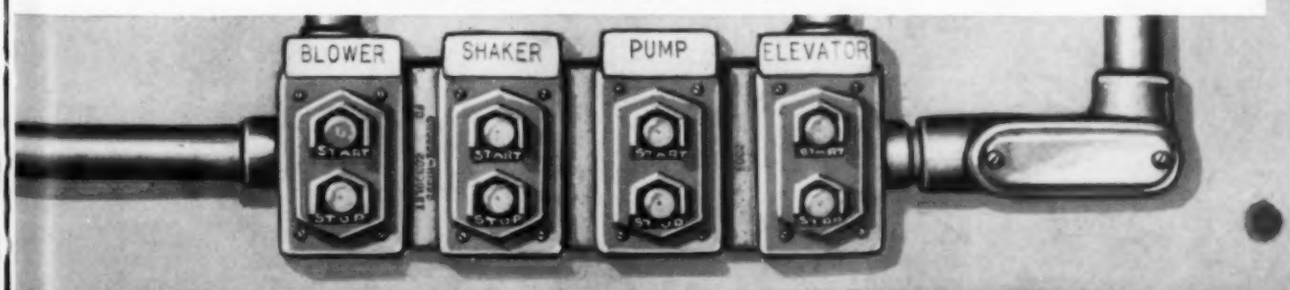
*Other definite advantages*

- **ECONOMY.** The installed cost of Crouse-Hinds CONDULETS and rigid conduit compares favorably with other wiring methods. The added advantages make it the really economical method that pays dividends over the years.
- **SAFETY.** Ground continuity is of vital importance. CONDULETS with taper threaded hubs and rigid conduit with tapered threads make a secure joint that provides a reliable and permanent low resistance path to ground. This safety feature assures maximum protection against personal injury and fire.
- **CORROSION RESISTING.** Cast Feraloy CONDULETS give the best protection wherever moisture, dust, or corrosive atmospheres are present.
- **FLEXIBILITY.** A modern CONDULET installation provides for growth and changing conditions. CONDULETS with detachable hub plates can be used to make it easy to change circuits or add new ones.
- **UNIVERSAL APPLICATION.** You can install galvanized CONDULETS and galvanized rigid conduit under all atmospheric conditions and in all occupancies.
- **SECURE ATTACHMENT** of devices. The mounting holes in CONDULETS are drilled and tapped in the cast metal body . . . no weak mounting ears to twist off.
- **QUALITY.** The trademark CONDULET stands for the highest quality, reliability, and long life.
- **VARIETY.** More than 15,000 items are listed in the CONDULET Catalog, including a complete explosion-proof and dust-tight line for use in hazardous locations.

On YOUR next electrical layout, plan to get all the benefits of sturdy cast Feraloy CONDULETS and rigid conduit . . . the universal wiring method.

**CROUSE-HINDS COMPANY**
**Syracuse 1, N. Y.**

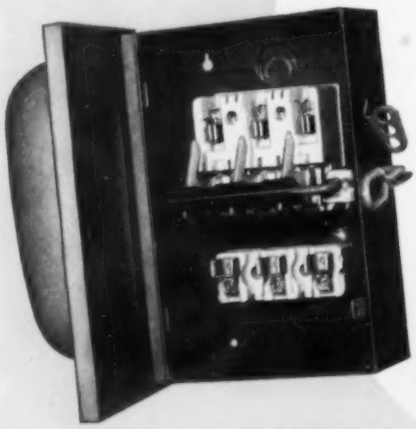
*Offices:* Birmingham — Boston — Buffalo — Chicago — Cincinnati — Cleveland — Dallas — Denver — Detroit — Houston — Indianapolis — Kansas City
Los Angeles — Milwaukee — Minneapolis — New York — Philadelphia — Pittsburgh — Portland, Ore. — San Francisco — Seattle
St. Louis — Washington. *Resident Representatives:* Albany — Atlanta — Baltimore — Charlotte — New Orleans — Richmond, Va.
CROUSE-HINDS COMPANY OF CANADA, LTD., TORONTO, ONT.




**AIRPORT LIGHTING · FLOODLIGHTS**

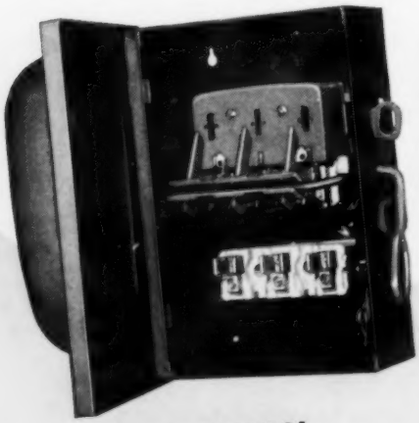
# 3 LINES OF SAFETY SWITCHES *for* 3 DIFFERENT MARKETS

**one line can't do two or three jobs without compromising price and performance!**



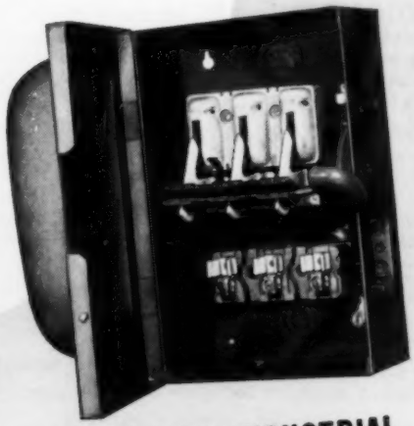
## GENERAL PURPOSE

**90,000 line** designed for residential, commercial and other applications where price is limiting and the service factor is not great.



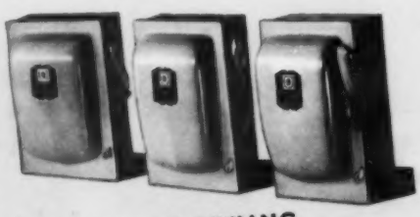
## INDUSTRIAL

**40,000 line** designed for general industrial or institutional and commercial applications where the service factor is greater and price is an important consideration. MEETS BOTH GOVERNMENT AND NEMA SPECIFICATIONS FOR TYPE A SWITCHES.



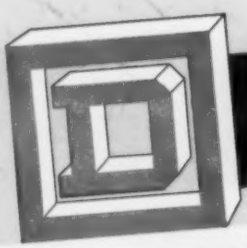
## HEAVY-DUTY INDUSTRIAL

**80,000 and 50,000 line** designed for mass production industries where price is secondary to continued performance under conditions of severe service and maximum safety. The 50,000 line is used where space is limited. BOTH ARE TYPE A but go far beyond those requirements.



UNIFORM STYLING

**ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS**



**SQUARE D COMPANY**

Another good example of Salem-Brosius leadership in diversified service to the ferrous and non-ferrous metals industries is the specially designed Brosius-Westling plate valve shown above. This ingenious mechanism is an offspring of the traditional "goggle" valve which has long been used to close massive mains containing dangerous gasses around blast furnaces and steel mills. Its major virtues are rapid shut-off and seal; easy, positive action despite long intervals of disuse; high structural strength combined with relative low weight. The development of the Brosius-Westling has so refined the principal of the sliding-plate valve that other industries currently are experimenting with its application.

*If you have a problem which involves the use of heating furnaces, blast furnace equipment, or charging and manipulating machines, it will pay you to call on Salem-Brosius today.*

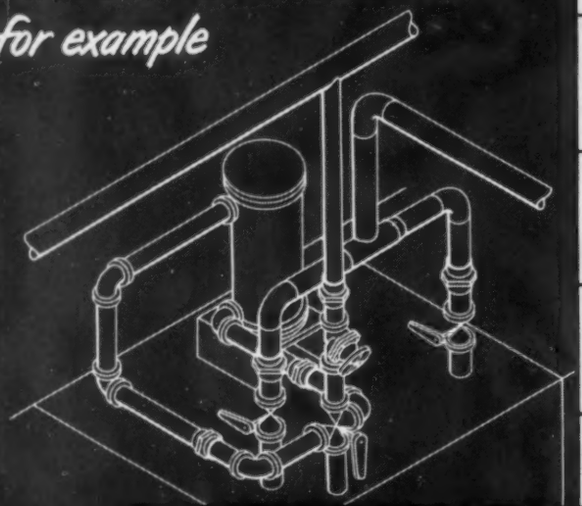
# SALEM-BROSIUS, INC.

SALES AND EXECUTIVE OFFICES: 248 FOURTH AVENUE, PITTSBURGH 22, PA.

BROSIUS DIVISION, PITTSBURGH 15, PA. SALEM ENGINEERING DIVISION, SALEM, OHIO

# Are Your Valves Behaving This Well?

...on River Water, for example



THE INSTALLATION

Crane Iron Body Diaphragm Valves on hydraulic lines to cylinder operators on ash pit gates; Southwark Station; Philadelphia Electric Company.

## VALVE SERVICE RATINGS

**SUITABILITY:** Good design for gritty fluid

**FEATURES:** Neoprene disc insert-resists cutting

**MAINTENANCE COST:** Making big savings here

**SERVICE LIFE:** Already 6 to 9 times longer than other valves

**CORROSION-RESISTANCE:** O.K. no sign of corrosion

**PRICE:** Better than many ordinary valves

**AVAILABILITY:** Regular number in Crane line

## THE HISTORY

Valves were installed in the hydraulic system when the control cocks failed to shut off tight. But like the cocks, conventional valves put in this service didn't stand up. They couldn't handle the abrasive, sandy river water used for hydraulic operators as well as for ash pit sluicing. They leaked badly in 3 to 5 weeks; had to be replaced.

The problem was solved with Crane Iron Body Diaphragm Valves. Installed more than 7 months, there's been no leakage since; no valve trouble of any kind. The Neoprene disc insert and wide, flat seating surfaces in Crane Valves show no effect of abrasion. Their completely sealed bonnet keeps working parts free of grit.

## THE VALVE

In Crane Packless Iron Body Diaphragm Valves, the Neoprene diaphragm acts as bonnet seal only; is not subject to crushing and rapid wear. Separate disc with Neoprene insert shuts off flow even should diaphragm fail. Made unlined or with full Neoprene body lining. Well suited for erosive fluids, sludges, slurries; also for many corrosive services. See your Crane Catalog or call your Crane Representative.

*The Complete Crane Line Meets All Valve Needs. That's Why*

**More Crane Valves Are Used Than Any Other Make!**

# CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois

*Branches and Wholesalers Serving All Industrial Areas*

***VALVES • FITTINGS • PIPE • PLUMBING • HEATING***

CLARK CONTROL
GEARED TO YOUR D.C. MILL NEEDS
BULLETIN 7313 TYPE VT VARI-TIME RELAY
BULLETIN 7400 TYPE RT VARI-TIME CONTACTOR
BULLETIN 7328 FORM LT OVERLOAD RELAY AUTOMATIC RESET TYPE
BULLETIN 7311 TYPE P PLUGGING RELAY

The four devices, pictured above, are geared to provide the ultimate in heavy duty mill operation, with minimum maintenance.

CLARK Bulletin 7400 D C. Vari-Time Contactors have a built-in Vari-Time core that delays, for a pre-set definite time, the closing of the main contacts after the coil has been energized. This combination of timing device and contactor eliminates one timing relay for each accelerating step. Fewer devices spell "LESS MAINTENANCE."

CLARK Bulletin 7313 DC Timing Relays are simple, yet ruggedly constructed. They perform timing functions—time delay up to and including ten seconds—with high fidelity. Each Vari-Time core is hermetically sealed and guaranteed for the life of the apparatus and many have been operating successfully for twenty-five years, with no care or maintenance.

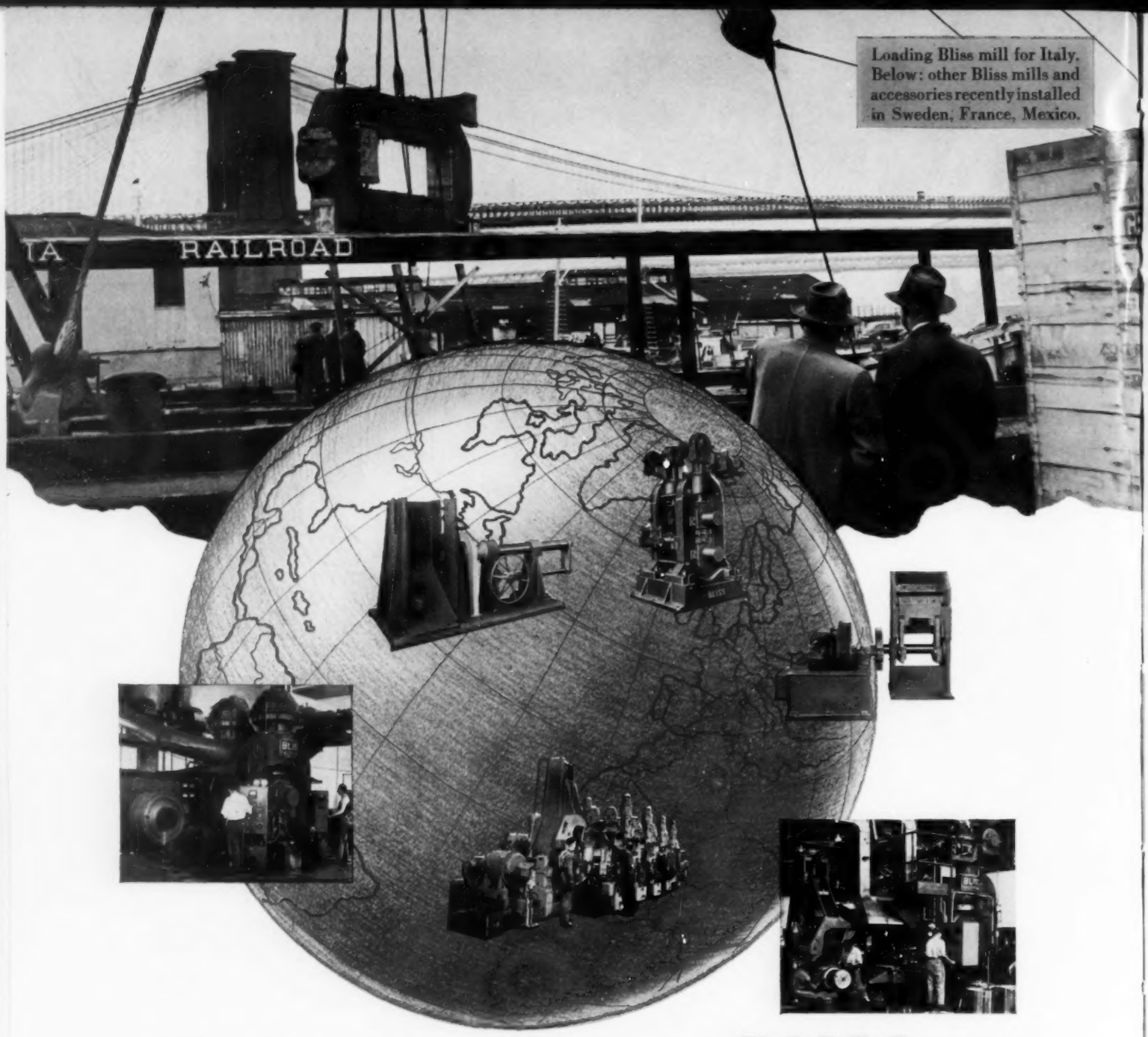
CLARK Bulletin 7328 D.C. Magnetic Overload Relays provide both inverse time limit and instantaneous protection utilizing the time proven Vari-Time principle. The sealed-in mechanism assures positive motor protection under the most adverse conditions.

CLARK Bulletin 7311 Plugging Relays feature rugged simplicity of design, and "fail-safe" operation. They afford maximum electrical and mechanical protection to the equipment.

*Consult our nearest District Office for complete information on Clark DC Mill Control.*

**THE CLARK CONTROLLER CO.**

ENGINEERED ELECTRICAL CONTROL • 1146 EAST 152ND STREET, CLEVELAND 10, OHIO




Loading Bliss mill for Italy. Below: other Bliss mills and accessories recently installed in Sweden, France, Mexico.

# The Free World Rolls on BLISS Mills

Bliss four-high cold-reducing mills to Italy...Bliss hot-strip mill auxiliary equipment to Brazil...Bliss mandrel-type hot coiler to Sweden...Bliss four-high aluminum mill to Mexico...Bliss reversing hot-strip mill to France...

And so it goes. More and more of the free world's metal-processing plants are calling on Bliss for the same modern, precision rolling mill equipment that has performed so well in the leading steel, brass and aluminum plants of the United States.

Bliss is proud of its ever-growing part in increasing production of metals so vital to the security of the free world. We welcome the opportunity to supply still more metal-rolling equipment.

Bliss builds a *complete* line of rolling mills and accessories to suit your hot or cold rolling needs. You're likely to find just the right mill or accessory to increase plant production and efficiency in the colorful, 52-page Bliss brochure. Write for it today.

E. W. BLISS COMPANY, CANTON, OHIO

ROLLING MILL DIVISION: SALEM, OHIO

E. W. Bliss (England) Ltd., Derby, England

E. W. Bliss Company (Paris), St. Ouen sur Seine, France

**Branch offices** in Chicago, Cleveland, Dayton, Detroit, Indianapolis, New Haven, New York, Philadelphia, Rochester, Toledo; and Toronto, Canada. **West Coast Representatives:** Moore Machinery Company, Los Angeles and San Francisco; Star Machinery Company, Seattle. **Other dealers** in United States cities and throughout the world.

*Bliss' rolling mill engineer in Paris provides a complete engineering consultative service for European metal producers.*

***Remember: for Presses, ROLLING MILLS, Special Machinery...*** **IT'S BLISS!**

# NEW

# Fast Arc Blowout

Two Type 260 DC Contactors, 150 amp, single pole, normally open, with auxiliary switch. One arc chute has been removed to show control detail. Type 260 DC Contactors with the new Arc Centering Feature are rated 600, 300 and 150 amps at 600-volt maximum.

## ALLIS-CHALMERS Mill Type 260 DC CONTACTOR

- Speeds Arc Interruption
- Extends Contact and Chute Life

THIS NEW HEAVY DUTY CONTACTOR offers an *entirely new* principle of arc interruption . . . developed by Allis-Chalmers engineers to meet the exacting needs of industry.

Contact and arc chute life have been greatly extended by an *arc centering blowout*. In centering the arc, increased blowout action and fast interruption results from a combination of thermal convection and magnetic action. Contact erosion is reduced and carbonization is minimized.

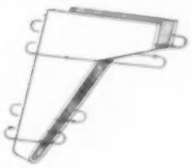
Other advantages of the Mill Type 260 DC Contactor include: accessible construction for easy maintenance; ROLLING contact action with no destructive scuffing; design simplicity which has eliminated troublesome linkages, arms and pivots.

The Type 260 DC Contactor featuring the new arc interruption principle has been designed and built to steel mill engineers' specifications. Years of field and factory tests have proved this heavy duty contactor far exceeds NEMA requirements . . . have established it as an efficient, trouble-free performer under the most severe operating conditions. Call your nearby Allis-Chalmers District Office or write to Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 14B6505A.

A-3909

### How Arc Interruption Principle Works

Arc Chute Assembly consists of triangular metal plates with U-shaped segments mounted alternately. Plates are insulated from each other and are placed at right angles to circumference of contact travel.



Metallic segments act as individual blowout coils.

Arc is forced upward along arc runner by blowout coil and impinges on metal segment of arc chute.

As contacts separate further, arc is stretched across an increased number of segments.

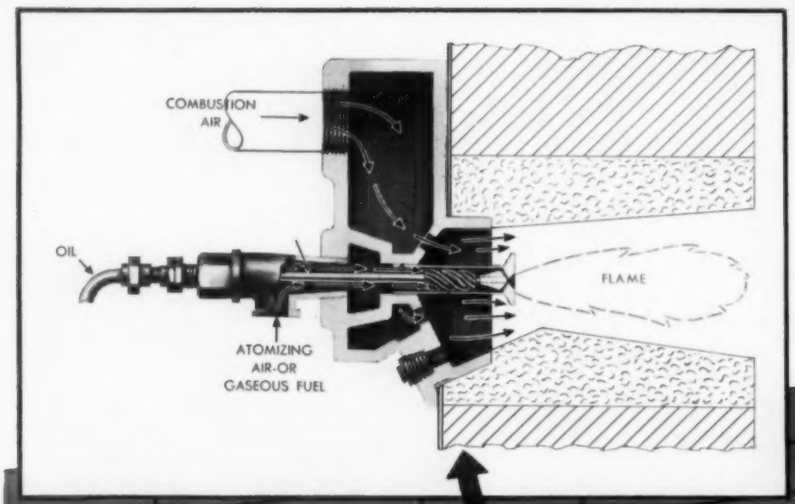
Arc rises quickly due to thermal and magnetic action of each individual metal segment.

**ALLIS-CHALMERS**

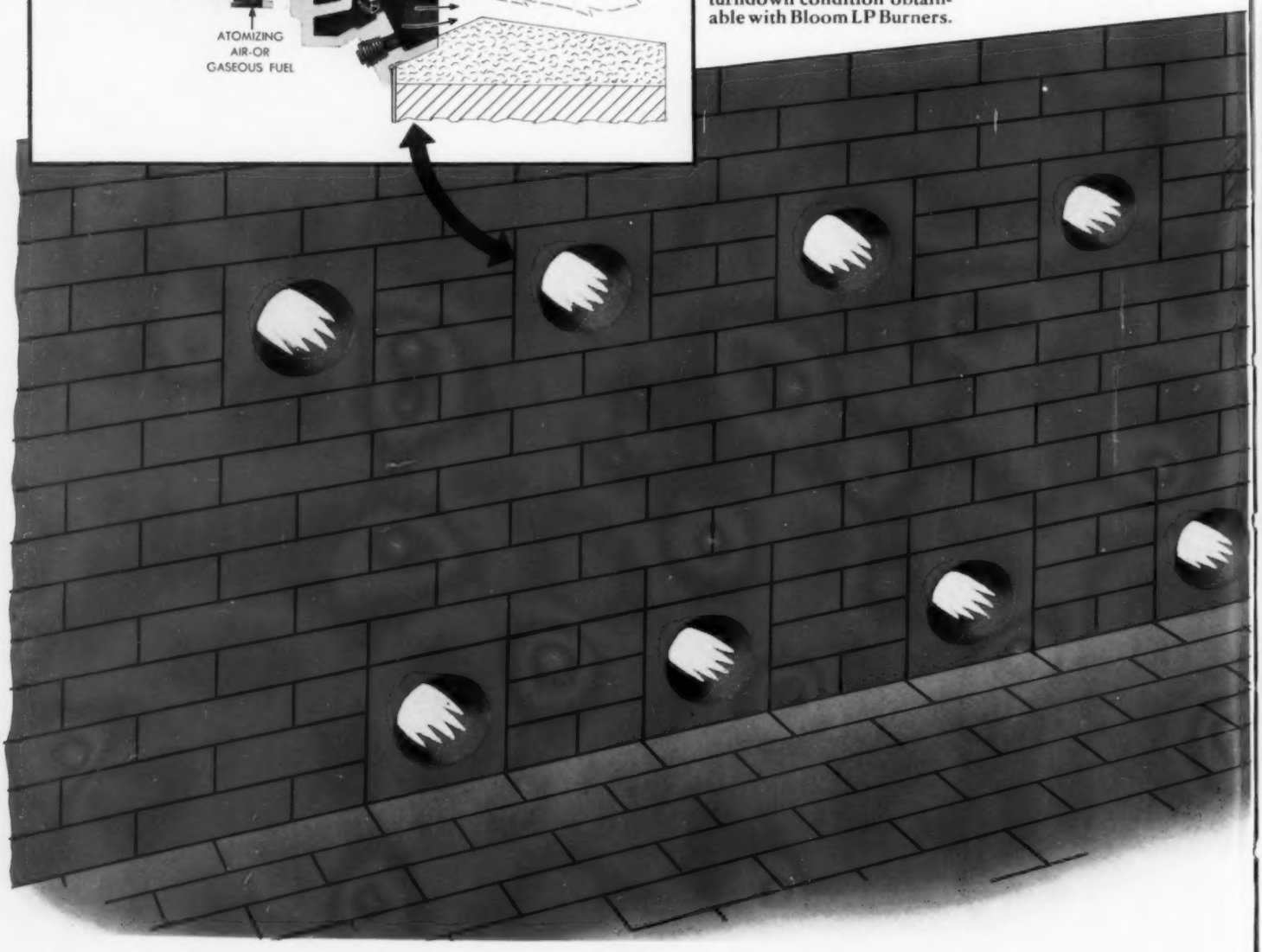
# ANNOUNCING

## The BLOOM LP OIL BURNER

Low-pressure 16-oz. air atomizing

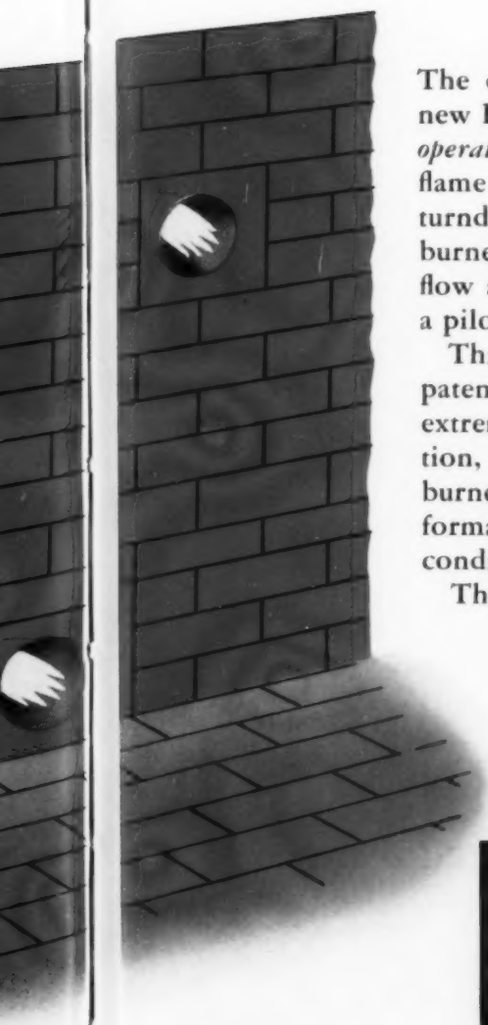



Section through LP Burner and view of typical furnace wall, showing the ideal low-turndown condition obtainable with Bloom LP Burners.



# Designed to solve 3 problems:

*WIDE RANGE TURNDOWN on oil operation*
*FLAME STABILITY at extremely low fuel input*
*ACCURATE BURNER CONTROL without intricate adjustments*



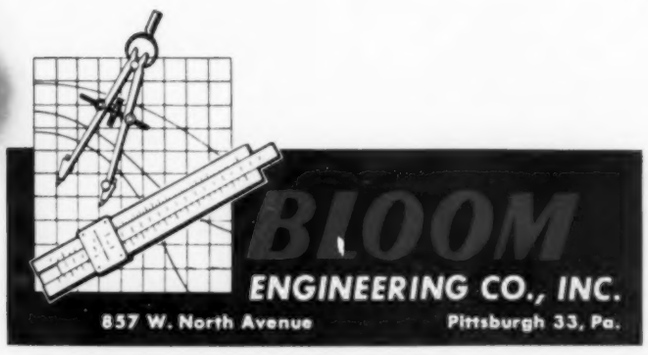
The outstanding feature of the unique new Bloom LP Oil Burner is *dependable operation at extremely low input.* Stable flame conditions are maintained over a turndown range of 10 to 1, and the burner operates satisfactorily with oil flow as low as ½ gal. per hour without a pilot.

Through the combination of the Bloom patented Flame Retention Nozzle and an extremely efficient method of atomization, (using 16 oz. air pressure), this burner provides highly satisfactory performance over a wide range of heating conditions.

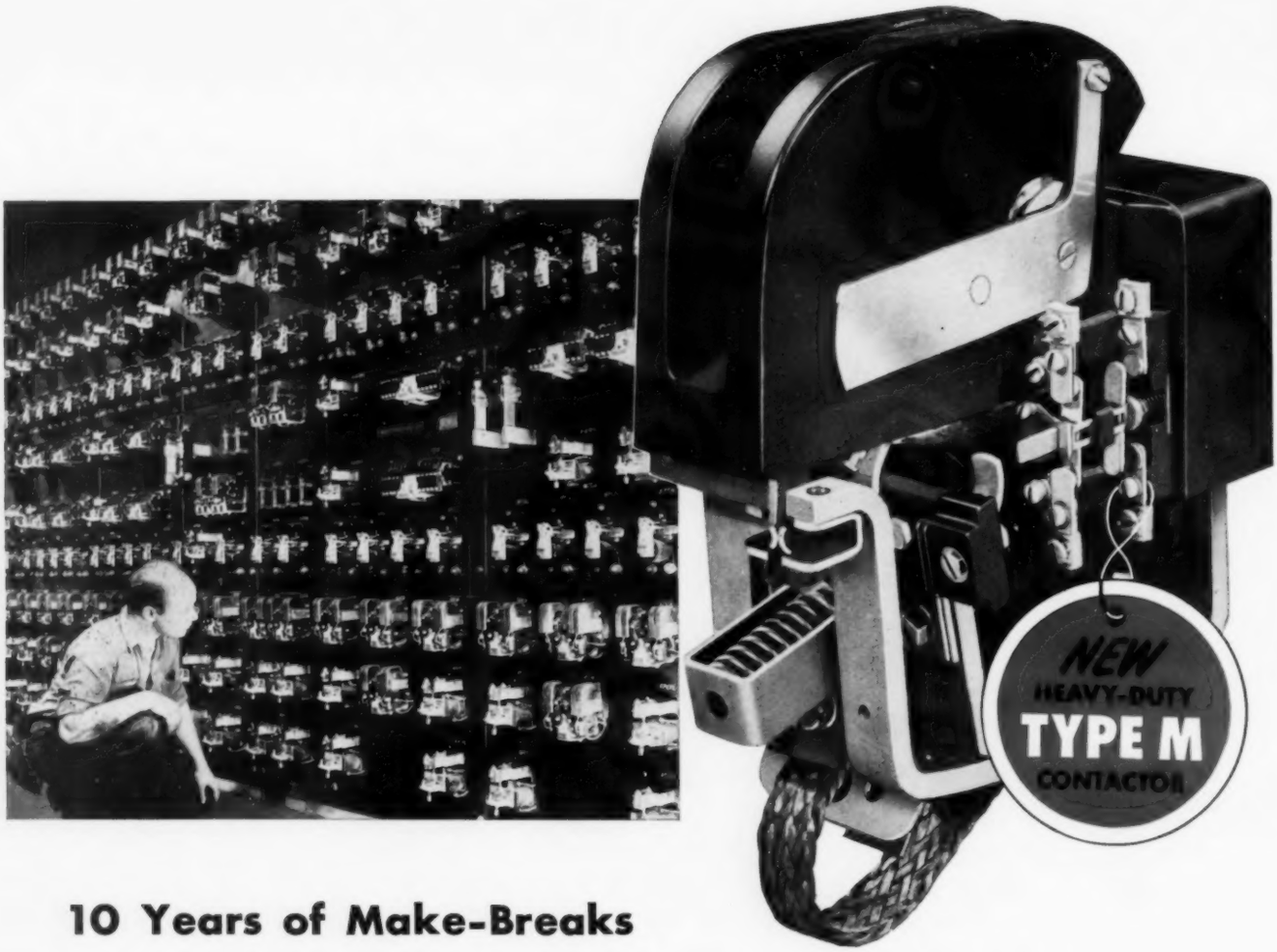
The Bloom LP Oil Burner has no moving parts. No individual burner adjustments need be made to change heating conditions. Control is easily and quickly accomplished through the customary zone control fuel valves.

With the Bloom LP Oil Burner you get:

- ★ A wide range of turndown—10 to 1
- ★ Dependable operation at flows as low as ½ gph.
- ★ Complete, accurate control using zone control valves; rather than complicated mechanical linkages for burner adjustment
- ★ Equal distribution of fuel between individual burners without delicate burner adjustments. Maximum flexibility of furnace operation



*WRITE* for new bulletin describing in greater detail the design and operation of the Bloom LP Oil Burner. Ask for bulletin C-220.




## 10 Years of Make-Breaks

# *Prove TYPE M Dependability*

## on Weirton Steel's Tin-Plate Line

If dependability and trouble-free operation interest you, here's a contactor worth knowing about. It's new—yet proved by ten years on-the-job testing.

Back in 1941, Westinghouse looked for the toughest applications to field test these contactors . . . picked locations for their severe duty. On numerous applications in five mills throughout the country, Type M Contactors went to work to prove themselves the most dependable yet developed.

One example was the first Tin-Plate Line constructed at Weirton Steel Co. Here, Type M's meet all Weirton's demands for dependability, low maintenance and long life. In fact, the successful operation justified using them in many other applications such as Shearing, Cleaning and other Plating Lines.

Millions of make-breaks proved the Type M dependability to Weirton Steel. You can prove it yourself. Ask your Westinghouse representative for full details on this contactor. Check the unit construction . . . unit mounted interlocks, "Qwik-Quench" arc box, and knife-edge bearings. Ask him today for a free copy of B-5261 and the complete Type M story. Or write Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pennsylvania. J-27013

YOU CAN BE SURE . . . IF IT'S
Westinghouse

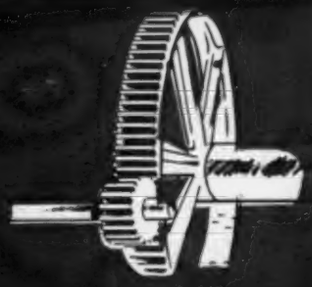
MOTORS and CONTROLS

# Amscoating

## The Right Way to Say Hard-facing for every Industrial Use

**AMSCO TOOLFACE** for metal to metal wear up to 1000° F. Deposits have high abrasion and impact resistance. All diameters bare and coated. Microstructure: martensitic steel.

**AMSCO TUBE TUNGSITE** (coarse particles) is best suited for applications requiring highly efficient cutting qualities, for hardfacing earth working and drilling equipment used for cutting extremely hard compositions, for hardfacing applications requiring a serrated edge and hard-facing certain types of earth working equipment or parts subject to extreme abrasion.



**AMSCO HF-60** for moderate impact and abrasion and has outstanding weldability particularly for vertical applications. All diameters, coated only. Microstructure: martensitic steel.

**AMSCO FARMFACE or AMSCO CHROMEFACE** for farm or industrial use. Excellent resistance to low stress sliding abrasion. All diameters, bare and coated. Microstructure: a high chromium austentitic iron containing manganese and silicon, and consisting of hard chromium carbides in a matrix of austentite.

**AMSCO No. 217** for abrasive service up to 1000° F. All diameters, bare and coated. Microstructure: an air hardening martensitic iron alloy containing chromium and tungsten.

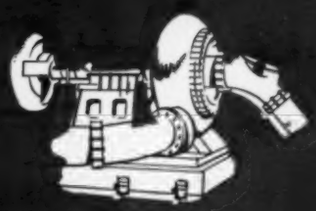
**AMSCO HF-40** for severe abrasion, moderate impact. Deposits have excellent weldability. All diameters, coated only. Microstructure: martensitic cast iron.

**AMSCO AIR-HARDENING** for abrasion and severe impact. Deposit can be forged to sharp edge without loss of hardness. All diameters, bare and coated. Microstructure: martensitic steel.

**AMSCO AW-79** will meet most requirements for better control of wear where abrasion and impact are important factors—plus all the advantages of automatic welding. Especially suitable for rebuilding and hardfacing tractor rollers, steel wheels, sheeting rolls, dredge pins, as well as dozens of other automatic applications. 3/32" and 5/16" in 22½" ID., 100 lb. coils.

**AMSCO V-MANG,** bare or coated, for build up and repair on manganese steel castings exposed to impact; work hardens—3/32", 5/16", ¼". Microstructure: austenitic manganese steel.

**AMSCO CO-MANG,** coated only, for build up and repair of manganese steel castings exposed to severe impact. Deposit has excellent impact resistance; work hardens—⅛", 3/32", 5/16", ¼". Microstructure: austenitic manganese steel.



**AMSCO TUNGROD** (fine particles) is best suited for applications requiring highly efficient cutting qualities, for hardfacing earth working and drilling equipment used for cutting extremely hard surfaces or formations, for hardfacing applications requiring a thin edge or small point, for hardfacing certain types of equipment or parts subject to extreme abrasion.

**AMSCO ECONOMY HARDFACE "C"** for abrasion resistant service and severe impact. All diameters, coated only. Microstructure: martensitic steel.

**AMSCO No. 1 and AMSCO No. 6** for combination of corrosion and abrasion or for 1000° F. service and above. No. 1 has greater abrasion resistance; No. 6 is tougher and can be machined. All diameters, bare and coated. Microstructures: No. 6 contains an eutectic carbide mixture in a solid solution matrix, while No. 1 contains large hard wear-resistant chromium carbide crystals scattered through a solid solution matrix.

**AMSCO No. 459** for severe abrasion, mild impact. Excellent abrasion resistance. All diameters, bare and coated. Microstructure: martensitic cast iron containing chromium and molydenum, consisting of hard carbides, austentite and martensite.

**To get the right answer, detailed analyses, and other pertinent information, concerning your wear problem, write for catalog 650W or contact your nearest Amsco Distributor.**

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**AMERICAN MANGANESE STEEL DIVISION**

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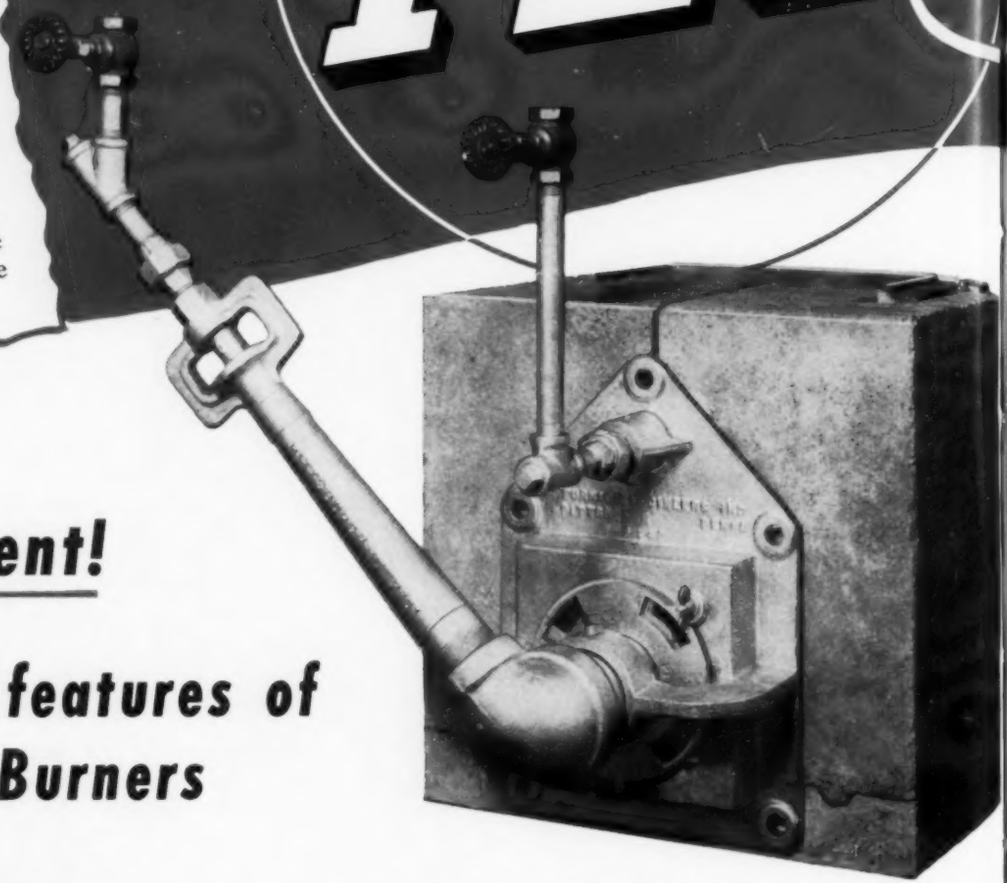
Silence is Golden...
It Speeds Production!

# F.E.I.

**Survey Shows Noise Cuts Down Production**

NEW YORK—A survey by a machine company found that noise cuts down production. After cutting its shop noise 35 per cent, the firm discovered production had risen 7.2 per cent. It also was discovered that noise fatigue caused 12 per cent of the absenteeism.



## Silent! Efficient!

## Check ALL the features of F.E.I. Patented Burners

✔ **ABSOLUTELY NOISELESS.** In one large steel mill, for example, over 1000 F.E.I. burners are in operation, yet you cannot hear noise from a single burner . . . So quiet that only by noticing position of stop cock handle, or by observing through inspection port, can you tell whether burners are on or off.

✔ **BURN ALL TYPES OF GASEOUS FUEL.** F.E.I. burners will burn any gaseous fuel from butane to clean producer gas . . . even cold clean blast furnace gas.

✔ **AUTOMATIC PROPORTIONING.** Strictly automatic proportioning for either low pressure or high pressure.

✔ **FLEXIBLE OPERATION.** Extremely smooth operation from highest upturn to lowest downturn . . . like that of a modern motor car whether going 60 miles per hour or idling. Unlike some burners that lose their correct proportion when 25% or less of maximum capacity is required, F.E.I. burners will go as low as 5% of rated capacity without losing their proper proportion . . . No backfire . . . No noise.

✔ **ALL TYPES AND SIZES.** Multi-jet, Nozzle Mixing, Luminous type, Long and Short Flame Burners, etc. Various sizes from the lowest requirement up to 5 million B.t.u., or higher, per hour per burner unit.

# Silent BURNERS

## provide a big PLUS advantage

### to users of industrial furnaces

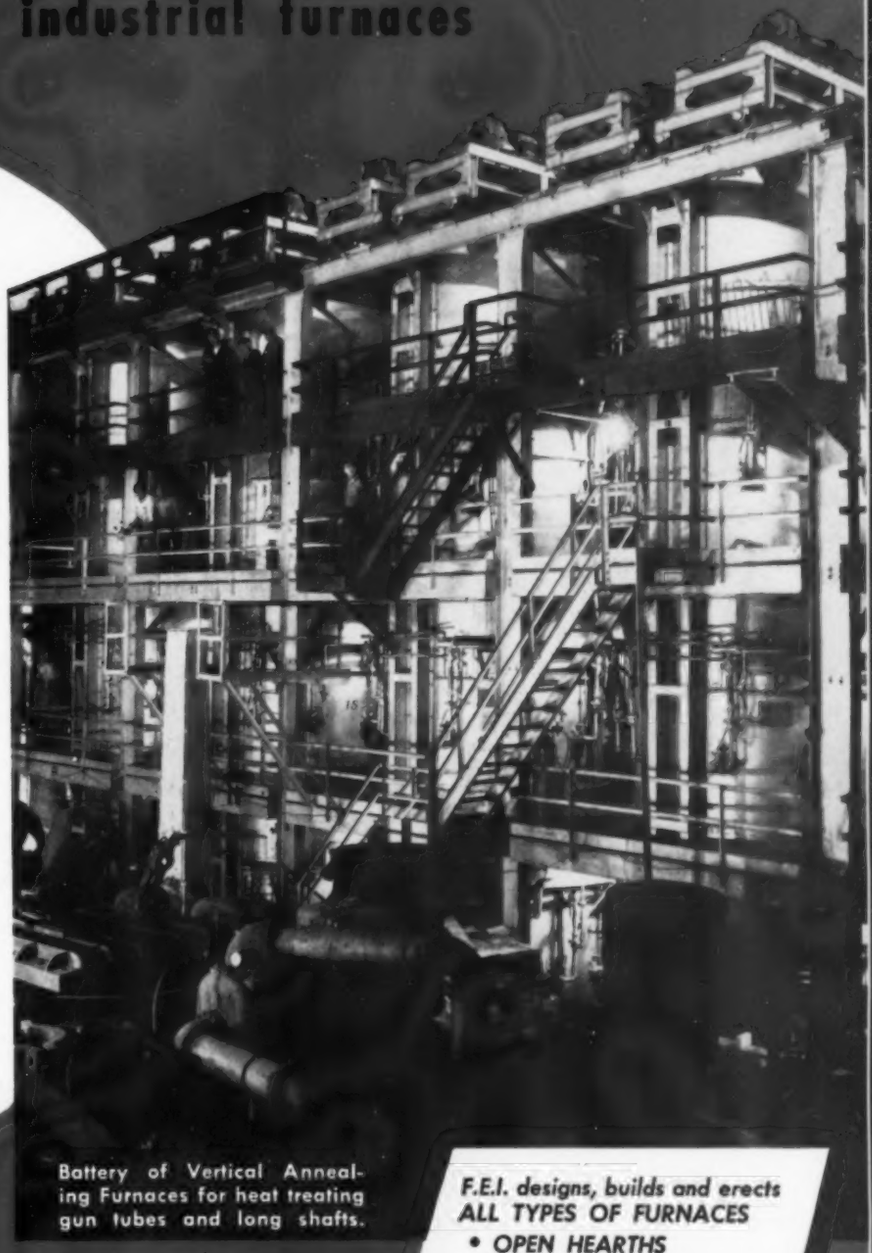
## Engineered for YOUR Job

**...whether it requires Burners alone, an entire Combustion System, or a Complete Furnace Installation.**

F.E.I. Burners are the ultimate in efficiency . . . a type for every specific need — for every kind of gaseous fuel. All F.E.I. Burners offer extreme flexibility under exact controls, engineered for completely automatic performance. They are adaptable for any application in the making and treating of ferrous and non-ferrous metals . . . for replacing old burners on existing furnaces or for completely new installations.

***WRITE FOR BULLETIN . . .***

***It tells about F.E.I. Service — complete from plan to operation***



Battery of Vertical Annealing Furnaces for heat treating gun tubes and long shafts.

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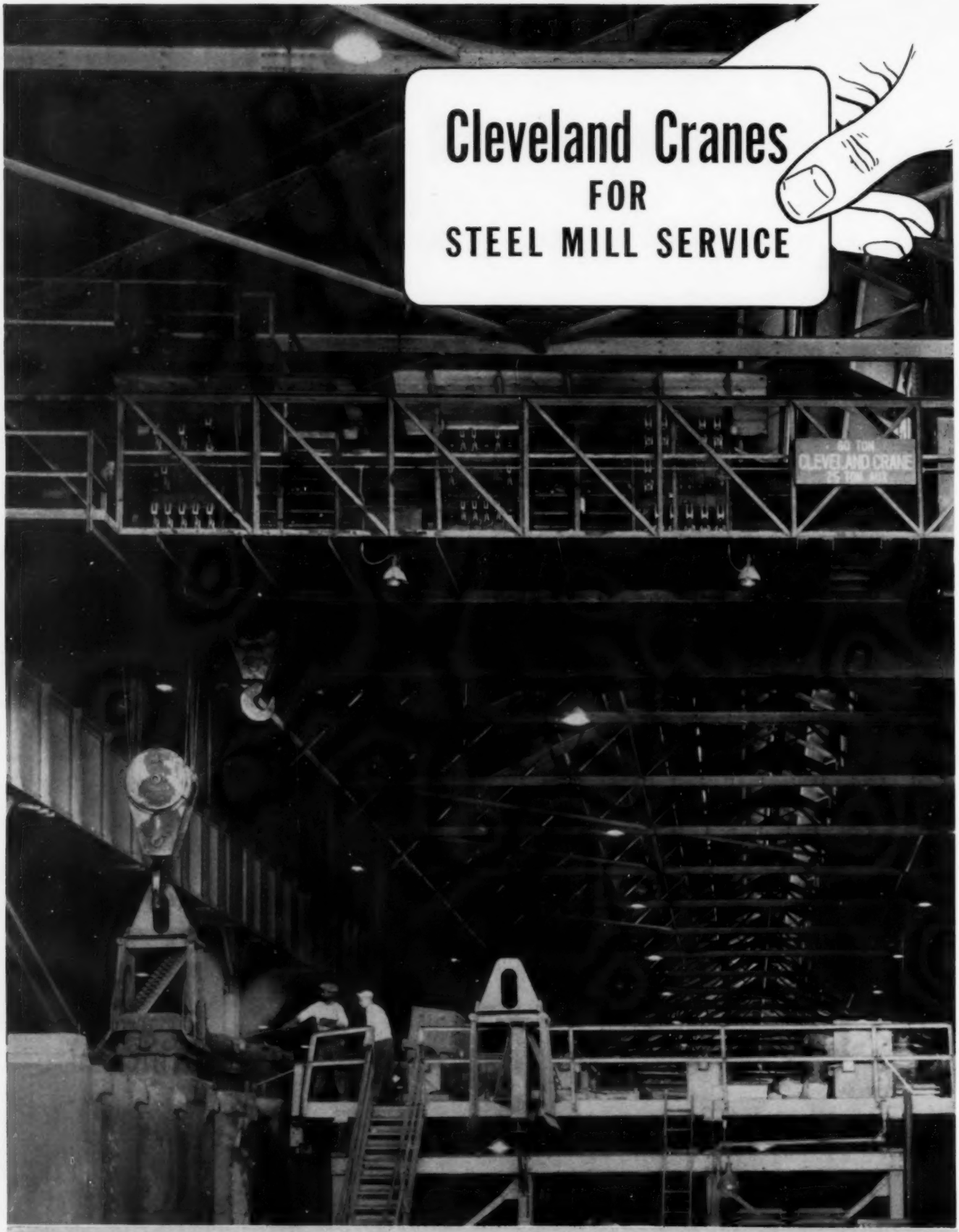


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MODERN ALL-WELDED STEEL MILL CRANES

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WICKLIFFE, OHIO

# Crops and Shorts

FINALLY, the election is over and the radio and television schedules have reverted to the professional entertainers. The people have spoken and Ike Eisenhower was chosen to be the next president of the United States. The verdict is a complete repudiation of socialistic trends, loose ethics and callous bias in government. The defeated candidate, Adlai E. Stevenson, seems to be a nice guy who lost principally because of a lot of handicaps not of his own making.

The new administration, while giving us the high quality of leadership we expect, must remember that it is the government of all the citizens and not just the 33,000,000 people who put it in office. The people, on the other hand, must unite behind the new administration to make America strong and safe.

▲

THE election results seem to indicate a trend toward realignment of various groups that have made up our two major political parties over the past 20 years. The popular vote in industrial areas shows that the labor vote is not a solid block to be delivered by their union leaders. In southern states, it shows that the old "solid South" is mellowing into factions that evaluate the real issues at stake. In all areas, it seems to show a trend toward a conservative group and a radical group, with a large liberal group in between, capable of swinging the balance of power either way, to act as a balance wheel and prevent either extreme from running rough-shod over the other.

▲

WITH the election over, we are no doubt in the last stage of the history of the political platforms, which is said to reach through the three stages of "planned, panned and canned."

▲

BEFORE we stop talking about the election, don't overlook the fact that the political pollsters and pundits were just as far off in their cautious predictions (or lack of them) this year as they were in 1948 when they burned their fingers on their predictions of a resounding Dewey victory.

▲

AN item in the press says that individual incomes in 1952 will reach a total of $256,400,000,000, and that people living in New York, Pennsylvania, Ohio, Illinois, Michigan, Texas and California will receive more than all the people in the other 41 states plus the District of Columbia.

They must have forgotten the $70,000,000,000 the tax collectors in Washington will receive.

▲

SPEAKING before the annual meeting of the Pennsylvania State Chamber of Commerce, Benjamin F. Fairless pointed out that true public ownership of industry is possible only under the capitalistic system, and that we in America have real and direct public ownership of our biggest industries. In fact, the 300,000 employees of United States Steel could obtain control of the corporation by buying up all its common stock. This would be about 87 shares apiece, which at today's market prices would cost less than $3500. At $10 a week, it would take each worker seven years to pay for his stock. Or voting control could be obtained if each employee bought 62 common shares at a cost of $5 a week for a period of ten years.

There's food for thought there.

▲

A SCIENTIST says that in 100 years there will be no blondes left in this country. Shucks, it's sorta hard to leave one now.

▲

ADDRESSING the Pittsburgh Regional Technical Meeting of the American Iron and Steel Institute, H. G. Batcheller condensed the major problems of the steel industry into the following:

Encroachments on industry by economic manipulators in government.

Encroachment by labor leaders on the functions of management.

Encroachment by excessive taxation on income that should be spent for plant modernization.

Improved technological processes.

▲

IT must have been a nasty old misanthrope who said that, before marriage, a man yearns for a woman — after marriage the Y is silent. And that a man is incomplete until he's married — then he's really finished.

▲

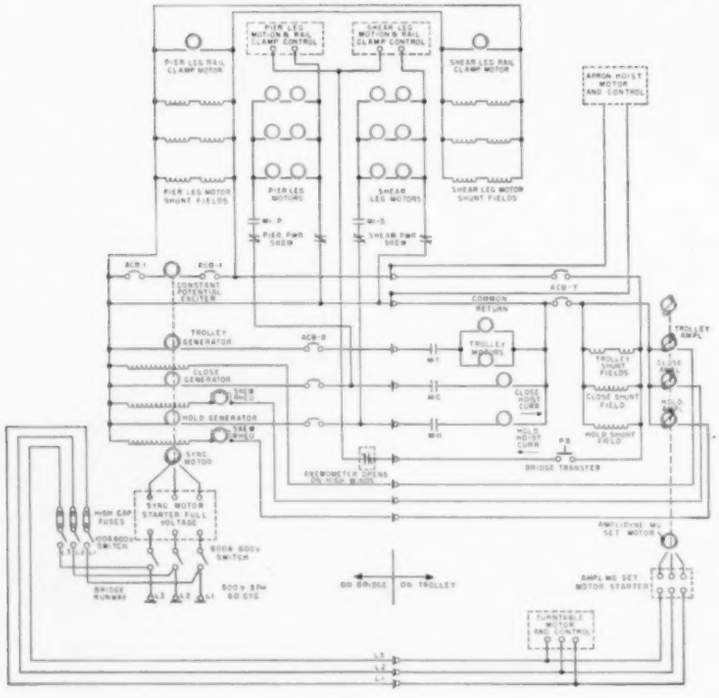
WAGE earners in the iron and steel industry averaged $2.139 per hour for the month of August, according to figures released by the American Iron and Steel Institute. This is 19.7 cents an hour more than rate prior to the new wage agreement. Wage earners worked an average of 38.2 hours a week in August, and employment totaled 659,800.

▲

INGOT production of United States Steel Co. in October soared to an all-time peak of 3,195,761 net tons. Numerous other company records were broken, and what are believed to be world records were set by the 45 in. slabbing mill at Homestead with a production of 214,842 net tons, and by the open hearth shop at the company's National Tube plant in McKeesport with an average output of 51.6 tons of steel per furnace operating hour.

**All electric equipment** for this new ore bridge was supplied by Canadian General Electric. Heyl and Patterson, Inc. of Pittsburgh designed and built the bridge for Dominion Foundries and Steel, Limited, of Hamilton, Ontario.

# New ore-bridge drive gives

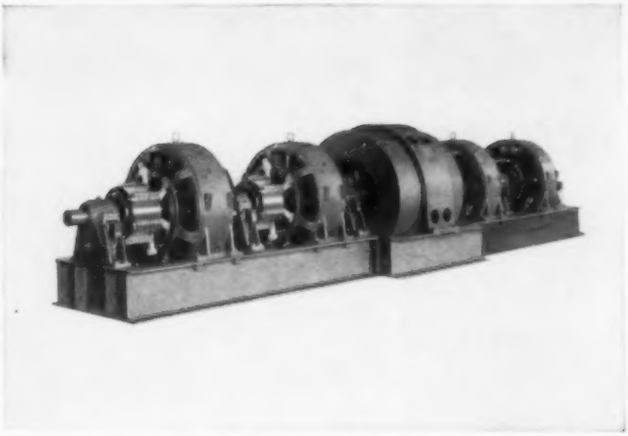



## How this new drive works:

The synchronous-motor-driven generators on the bridge structure supply adjustable-voltage power to the hold, close, and trolley motors on the man-trolley; also constant-potential power for motor fields, brakes, control, and the apron hoist. Each adjustable-voltage generator is controlled by an amplidyne on the man-trolley. In addition to voltage- and current-limit control, the hold and close line amplidyne circuits include provision for automatically matching motor loads when hoisting or lowering a closed bucket or matching motor speeds when lowering an open bucket.

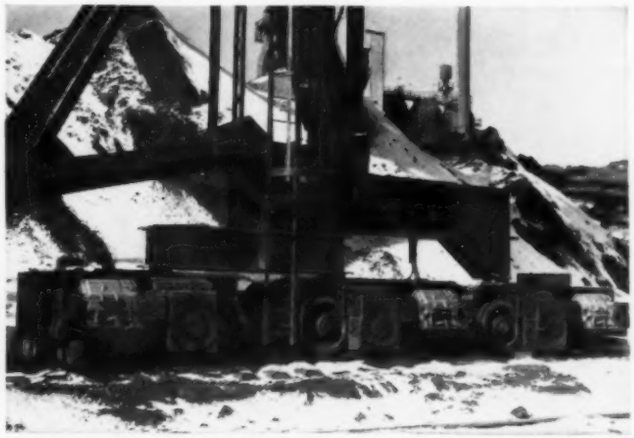
By means of a foot switch, the operator transfers the hold and close generators and control to the pier and shear leg drives; thereby obtaining smooth acceleration and deceleration of the bridge structure. Each leg may be controlled independently, but when operated simultaneously, automatic alignment is provided by means of skew rheostats.

***Another Example of G-E drive engineering at work!***

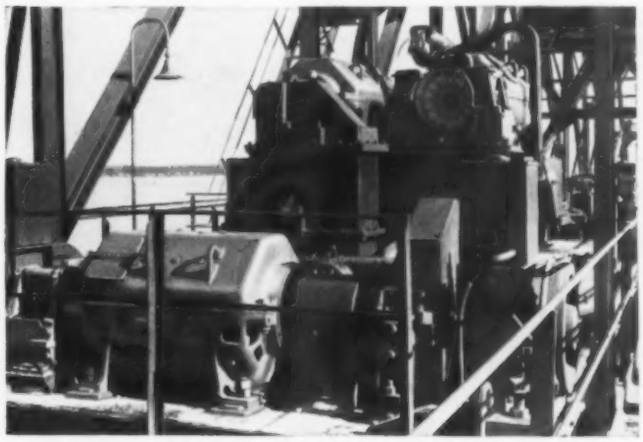


**Amplidyne-excited generators** in the main 5-unit m-g set (similar to one above) power trolley, hold, close, and bridge travel motors.

**Apron hoist** that permits raising apron for ore boat's entry is driven by a sturdy G-E 45-hp mill-type d-c motor.



**Three of 12 G-E mill-type d-c motors** and brakes that drive the shear and pier legs. Automatic skew control maintains alignment between legs.



**Top deck of trolley** contains four 150-hp continuous rated G-E mill motors for hold, close (on turntable) and trolley drives, each equipped with a G-E mill-type brake.

# more precise bucket control

## Amplidyne adjustable-voltage system also speeds trolley travel, cuts power losses and maintenance costs

Here is the first application of an amplidyne-controlled adjustable-voltage drive system to an ore bridge—engineered jointly by Canadian General Electric and Heyl and Patterson, Inc. of Pittsburgh. This drive system, already proved in other industries, now brings to ore bridge operation these major advantages:

**More accurate bucket control,** with less master switch handling and less operator fatigue, because load is divided and speed matched *automatically* between hold and close motors.

**Faster trolley travel,** with less shock to gears, because constant rate of acceleration and deceleration brings trolley up to full rated speed faster, stops it in less time.

**Less power consumption** because there are no banks of power resistors to cause power losses.

**Smaller, lighter trolley design,** because large banks of power resistors and heavy power contactors are eliminated, smaller frame motors and brakes are used.

**Less maintenance,** because resistors and power-interrupting contactors are done away with, smooth acceleration and deceleration minimizes stress on structural members.

What does this example mean to you? Simply this: G-E engineering successfully uses the *system* approach to solve any drive problem—including *yours.* For more information, contact your G-E steel-mill specialist or write for Bulletin GET-1789A. *General Electric Company, Section 659-89, Schenectady 5, N. Y.*

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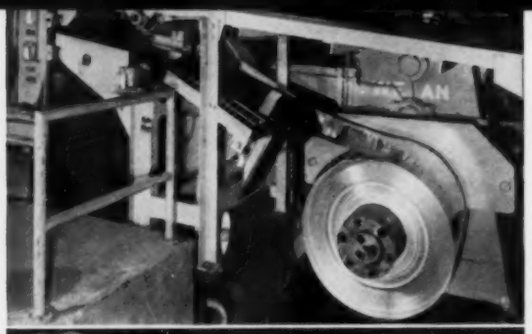

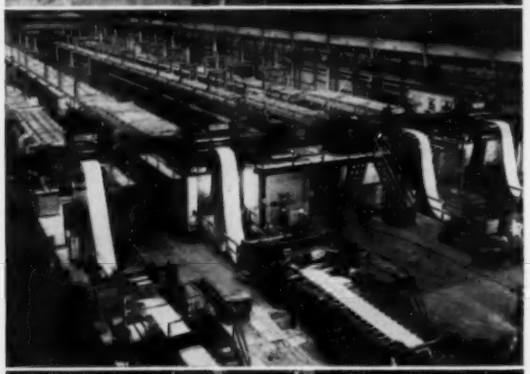

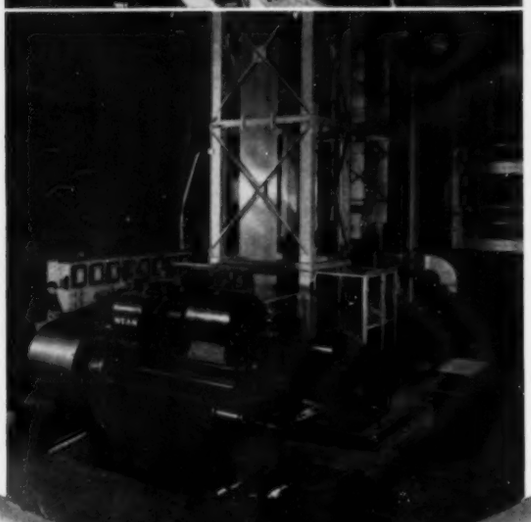

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# Iron AND Steel ENGINEER

NOVEMBER, 1952 VOLUME XXIX NUMBER XI

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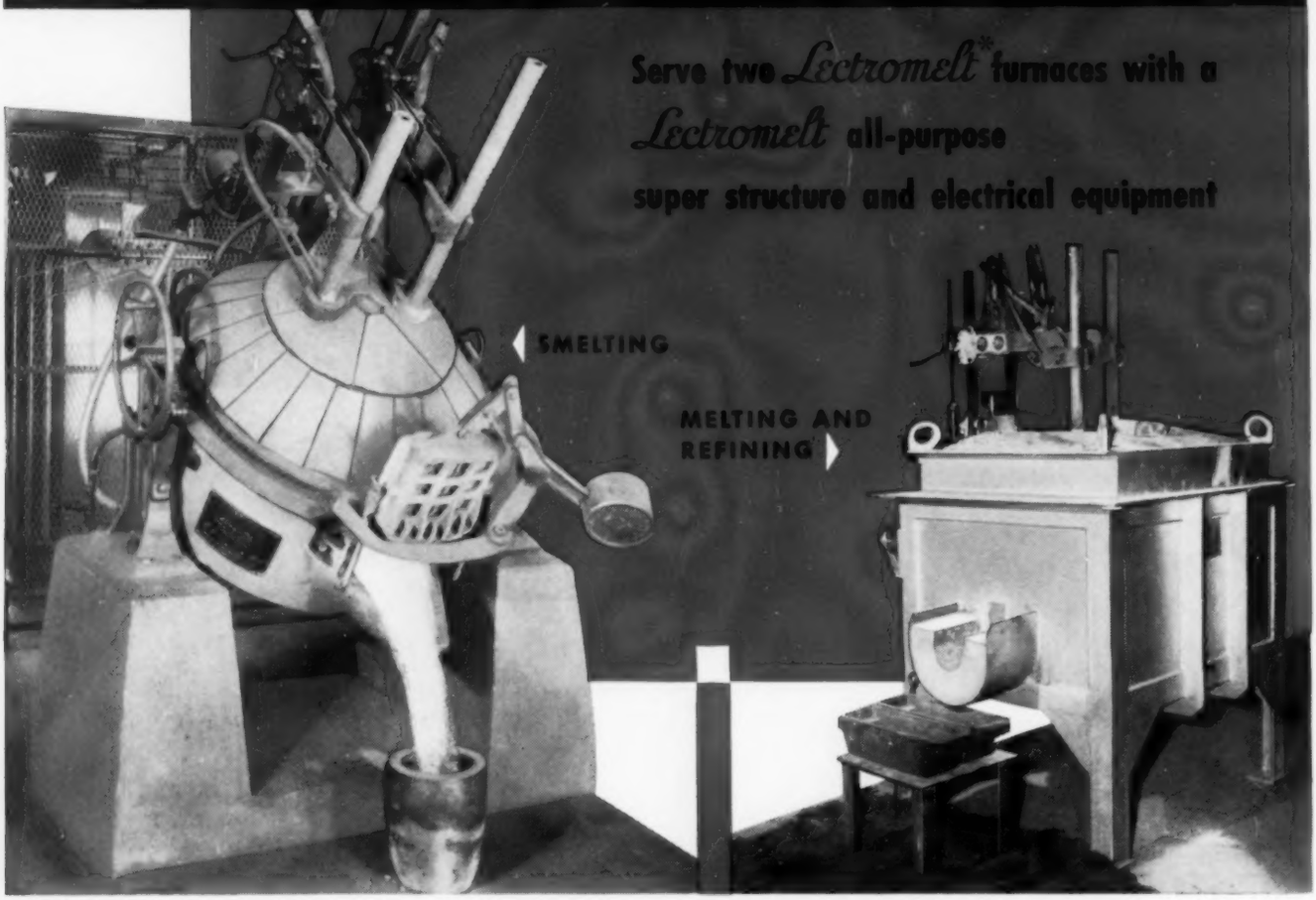


With these two furnace shells and the one Lectromelt superstructure, your laboratory can handle almost any problem having to do with electric furnace operations. The superstructure can be shifted from one furnace to the other, as required, along with its electrical equipment.

The combination at the left is designed for small scale, batch smelting of ores and concentrates, melting of non-metallics, melting and refining of metallics. The furnace at the right can be used for continuous operations in experimenting on the reduction of ores and melting of non-metallics.

Both furnaces can be employed with direct and indirect arcs. 50 KVA of power is available on low voltages and 100 KVA on high voltages.

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WHEN YOU MELT... MOORE RAPID *Lectromelt*

By A. H. GRIFFITHS
Superintendent of Rolling Mills
Kansas City Plant
Sheffield Steel Corp.
Kansas City, Mo.

# OPERATION OF A 12-IN. CONTINUOUS BAR MILL

***. . . . the mill described has a very economical roll layout as all of the pass sizes are in one set of rolls except for the leader and finishing . . . .***

▲ AT our Kansas City plant, the Sheffield Steel Corp. started operating in August, 1948, a 12-in. semi-continuous bar mill. This mill is housed in a building 745 ft long with an additional 435 ft serving as a billet storage area. Included within the building are the roll shop, bearing shop, motor rooms and other service facilities required for the operation of the mill.

Billets, in sizes of 2, 2¾, 3⅝, and 4-in. square, received in the billet storage area are unloaded by an overhead crane and placed in groups arranged as to size, heat number, and sequence of rolling.

From this storage area, these billets, in 15 to 20 ton lifts, are deposited by an overhead crane onto a billet charging platform. Here shuffle bars transfer the billets automatically across the platform to the roller table which feeds the furnace. A ram is mounted on a chain operated carriage, the wheels of which run on the side guards of the roller table. This ram pushes the billets into the furnace and is capable of charging one or several billets at a time.

The furnace is of the continuous type with a suspended roof, and a hearth 32 by 50 ft. It has a rating of 60 tons per hr and can be fired either by natural gas or by oil. Billets are discharged through the side door by a pinch roll pushout.

An up-and-down cut shear is located at the discharge door of the furnace and has a capacity to shear hot billets up to a cross sectional area of 18½ sq in. A mill approach table approximately 32 ft in length spans the distance from the up-and-down cut shear to the first roll stand of the mill. A shear gage is incorporated in this 32-ft distance for use when division of the billet length is required.

The mill consists of twelve horizontal roll stands, and three vertical edging mills — a total of fifteen stands. The roughing and intermediate mills are in straight continuous formation. Stands No. 9 and 10 are offset and are served by repeaters or by skew Y-tables. The rolls in Stands No. 1, 2, and 3 of the roughing mill are of 18 in. nominal diameter, 36 in. long; the 5-stand intermediate mill has rolls of 14 in. nominal diameter 32 in. long, and the finishing mill has rolls 13 in. in diameter and 24 in. long. The rolls in No. 1 and No. 2 edging mills are 13 in. in diam. Those in No. 3 edging are of special design and employ a variety of roll diameters. With the exception of stands No. 1-2 and No. 4-5, each roll stand is driven by an individual variable speed d-c motor. Stands No. 1-2 are powered by a 500-hp motor, while an 800-hp motor drives stands No. 4-5. Each of the remaining roll stands has a 500-hp motor. A 150-hp motor drives No. 1 edger, while No. 2 and No. 3 edgers are each driven by a 100-hp motor.

The roughing and intermediate motors are on the east side of the mill in the main motor room, while the finishing mill motors, on the west side, are under the mill operating pulpit. Instruments of the latest type for recording motor loads and speeds are installed on the switchboards.

The roll housings are of cast steel and of the closed top type. They are equipped with oil-flooded tapered neck sleeve bearings. Roll adjustments are made by top screws and by wedges under the bottom roll neck bearings actuated by horizontal screws. All adjustments including end thrust of the roll can be performed from the working side of the mill. The roll and pinion housings are arranged for sliding upon their bedplates, by means of hydraulic cylinders. The reason for mounting the roll and pinion stands slidably on the bedplates is to permit the roll grooves of adjoining rolls to be in strict alignment at all times. Regardless of the number and the spacing of the passes in any roll, the grooves in adjoining rolls can be aligned, so eliminating all side deflection of stock between stands. A flying shear follows No. 7 stand. All mill pinions, gears and their bearings are lubricated by a continuous filtration, pressure type, lubricating system.

For the repeating of merchant bar, two 180 degree repeaters are used. Bars with areas too large for repeating are transferred by skew Y-tables from No. 8 to No. 9 stand and from No. 9 to the finishing stand. These tables are controlled from the mill pulpit by the skew Y-table operator.

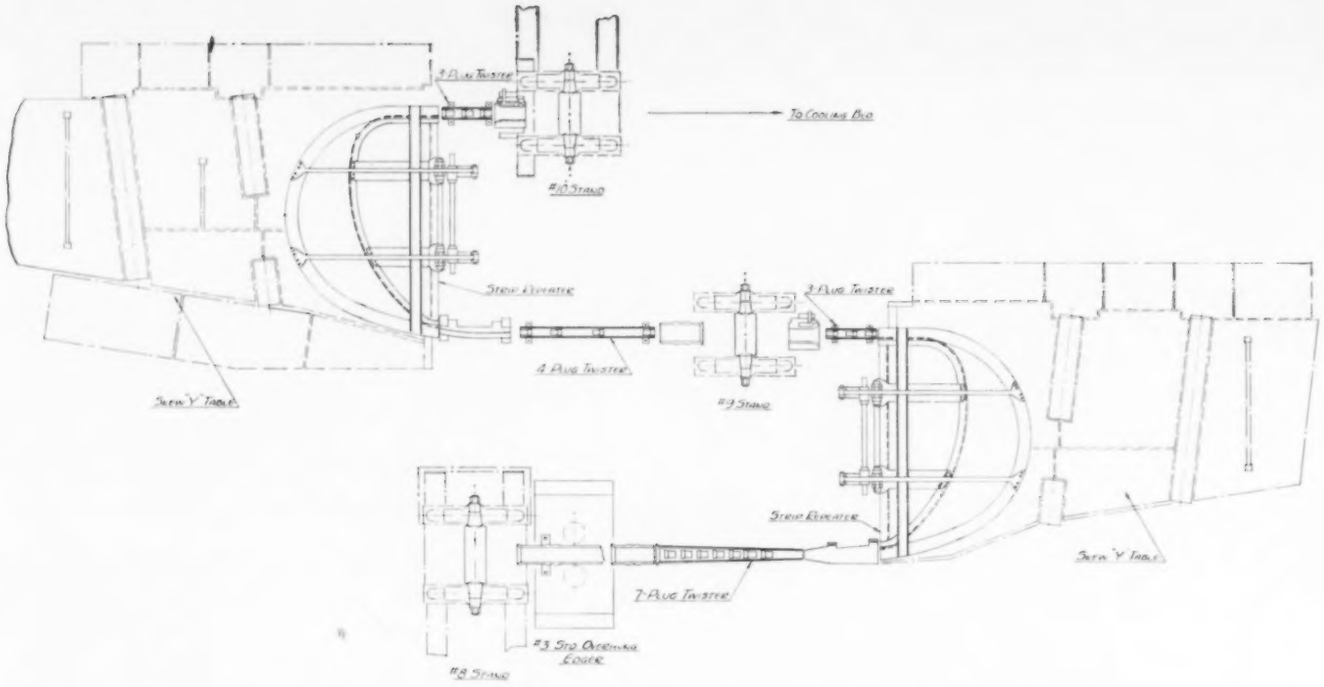



**Figure 1 — Sketch shows method for repeating angles from 1½ x 1½ in. to 2½ x 2½ in. inclusive.**

The finished product of the mill can either be coiled or delivered to a cooling bed. All coiled merchant bar and nut flats are delivered to two pouring reels. The coils have an outside diam of 46 in. and an inside diam of 34 in., and weighs approximately 750 lb. The coils are transferred horizontally by a motor-driven push-off onto a conveyor approximately 200 ft long. The chain of this conveyor fills its groove completely, so preventing stray ends from getting caught in the moving chain. A hook carrier, synchronized with this conveyor, is used to carry the coils to a point where they are to be loaded onto cars or put into storage. While the coils are moving on the hook carrier they are inspected, trimmed and tied. An air operated hook is used to remove the bundles from the carrier. The hook carrier is about 800 ft long.

A roller table, 164 ft long, separates the finishing stand from the cooling bed. This table contains a rotary disc shear capable of cutting bars up to 1⅛ in. in diam. To make a cut, this shear is tripped automatically when the front end of the bar reaches an insulated roller located in the runout table of the cooling bed. The cooling bed is of the carryover type, consisting of stationary and moving notched racks. After passing across the notched surface, the cooled product is transferred by shuffle bars onto the front shear table. At the stationary shears, the bars are cut to length and then moved by an overhead crane to the shipping department.

The range of sizes that are coiled are:

Rounds ½ to 1 in.
Nut flats ⅞ × 35/64 in. to 1¼ × 11/16 in.

The products going to the cooling bed are:

Rounds ½ to 2 in.
Flats 1½ × ⅛ in. to 6 × ⅝ in.
Angles 1¼ × 1¼ in. to 3 × 3 in.
Concrete reinforcing bars from ½ to 1¼ in.
Nut flats 25/32 × 33/64 in. to 2 1/32 x 1 37/64 in.

This 12-in. bar mill went into operation in August, 1948; and during the three years experience with this mill, we have made some changes from the original design even though the performance of the mill has been satisfactory.

Though the heating furnace follows well-established principles of design, we propose to alter, with the cooperation of the mill builder, some features of the details of this furnace to increase its capacity up to 80 tons per hour from its present 60 tons, and also to bring the soaking zone slightly more forward. This we propose to do by installing a double bank of 13 burners and putting a knuckle in the furnace roof.

We had a heating problem that took us some time to overcome, for instance, if we were rolling ½ in. rounds, and the mill was rolling a good bar when they shut down at the end of the turn, the furnace was down for an eight hour interval, and when we started up on the same size with the same mill setup and speeds as used on the previous turn, we would invariably have cobbles. After investigating this condition, we found that most of our trouble was due to the first five or six billets on the hearth were not to rolling temperature. Until these burners are added, the mill operator helps control this condition by increasing the No. 1 voltage generator five to ten volts, which increases the speed of the roughing and intermediate train.

Our mill was laid out for an extremely large range of product. In rounds this range was from ⅜ to 2 in. in diam. To accomplish this it was felt that Stands No. 11 and 12, arranged in tandem with Stand No. 10, would provide the necessary additional passes to obtain the smaller sections.

Recognizing however, the low tonnages which the rolling of the smallest sizes would yield from a 12-in. mill with the importance of this unit, the management concluded to limit this mill's production to a minimum of ½-in. rounds, and to roll the smaller sizes on our combination 10-in. rod and merchant mill. This decision

did away with the necessity of employing Stands No. 11 and 12 with the attending delay of having to change a larger number of rolls; therefore, these roll stands have been removed.

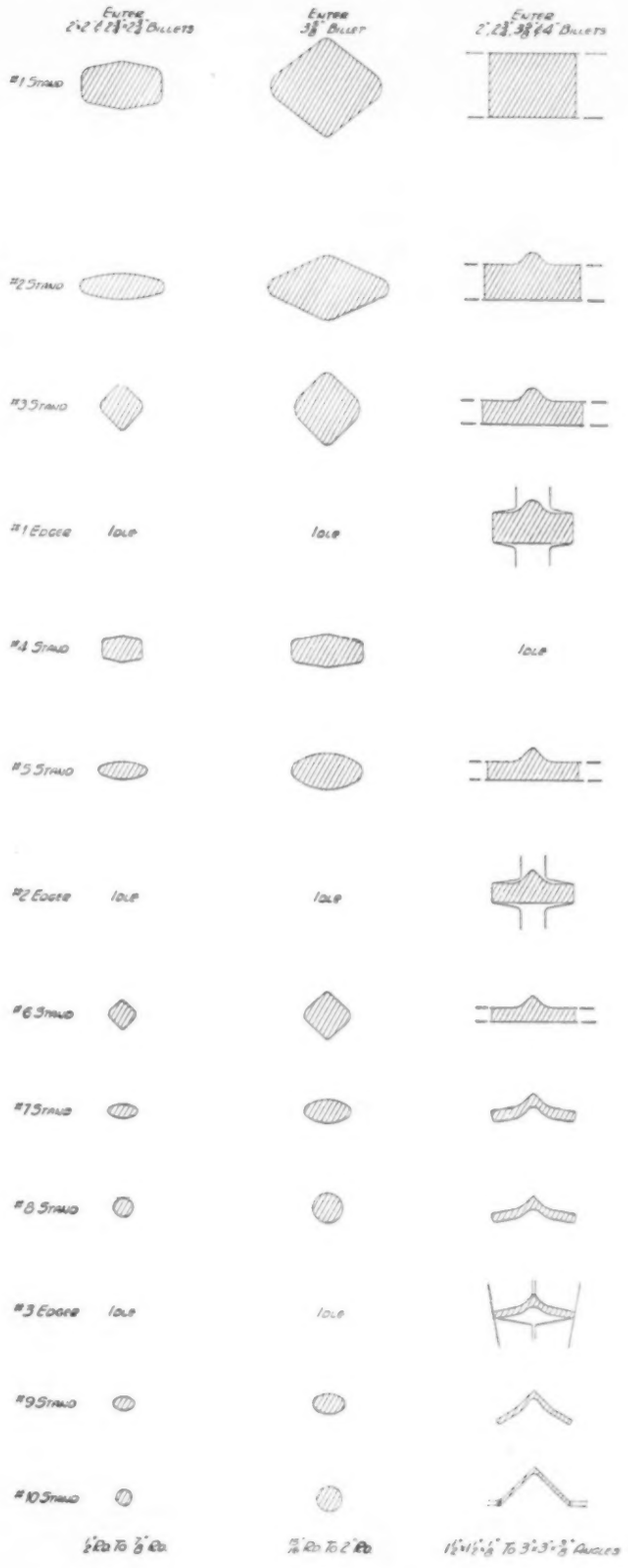
On rounds of 1 in. and larger, the design was for allowing the bar to run out on the skew Y-table. This created a problem when trying to run your square into the leader oval pass, because the square would be twisting as it entered the oval, and we could not use a tight entering guide box to hold up the square. It was decided to change all of our square to a round, which eliminated the problem of twisting of the bar when entering the oval. This has been done for all rounds from ½ to 2 in. Repeaters on both sides of the mill are used from ½ to 1¼ in. rounds. When rolling 1⅜ in. and 1½ in. rounds, we remove the repeater between No. 8 and No. 9 stand, using the skew Y-table, and repeat between No. 9 stand and the finishing. Rounds of 1¾ and 2 in. in diam are skew Y on both sides of the mill.

When rolling 1 and 1⅛ in. rounds from a 3⅝-in. billet, it was necessary to use the crop shear between No. 7 and No. 8 stand due to split ends when rolling from the original oval in No. 1 stand and diamond in No. 2 stand. By changing oval in No. 1 stand to a 102 degree diamond and No. 2 stand pass to a 130 degree diamond, and using a 3½-in. billet, made it possible to eliminate the cropping of the bar and also the trouble caused by split ends.

Another problem arose when we tried to deliver our ½ and ⅝ in. deformed rounds on the cooling bed at 2000 fpm, and after having many cobbles on the bed, we found that the shear, which was only 75 ft away from the bed, did not allow enough gap between bars. It was necessary to cut our finishing speed down to 1800 fpm to get sufficient gap between bars. We plan to move the shear back 40 ft toward the finishing stand in order to increase the gap between bars. This was made possible when we eliminated Stands No. 11 and 12.

There was a great deal of deliberation when the mill was first being considered about the use of oil-flooded tapered neck sleeve bearings. During the three years of operation of this mill, only one incident marred the otherwise perfect record of no lost time due to bearing trouble, and this happened while the regular millwright was on vacation. We were asked by the builders of the mill to provide a separate shop for the handling of these bearings, for removing them from used rolls and applying them to dressed rolls. Apart from the quality of the bearings, credit for their excellent performance must be given to the man in charge of the shop for his interest in the welfare of the bearings and to the splendid housekeeping that is maintained in his shop.

**Figure 2 — Sketch shows method for rolling round and angle sections on 12-in. bar mills.**



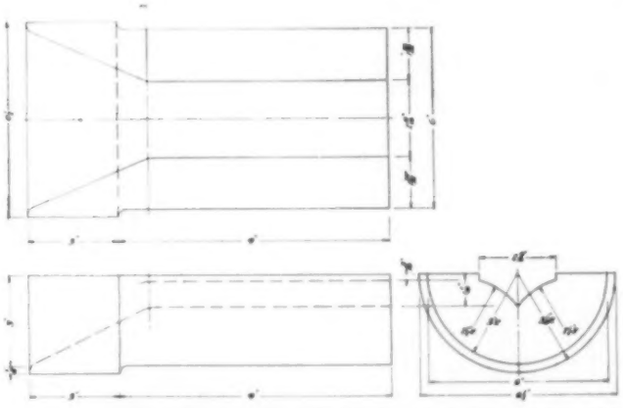



**Figure 3 — This common twister plug is used as a top plug for 1¼ and 1½ in. angles on No. 8 stand.**

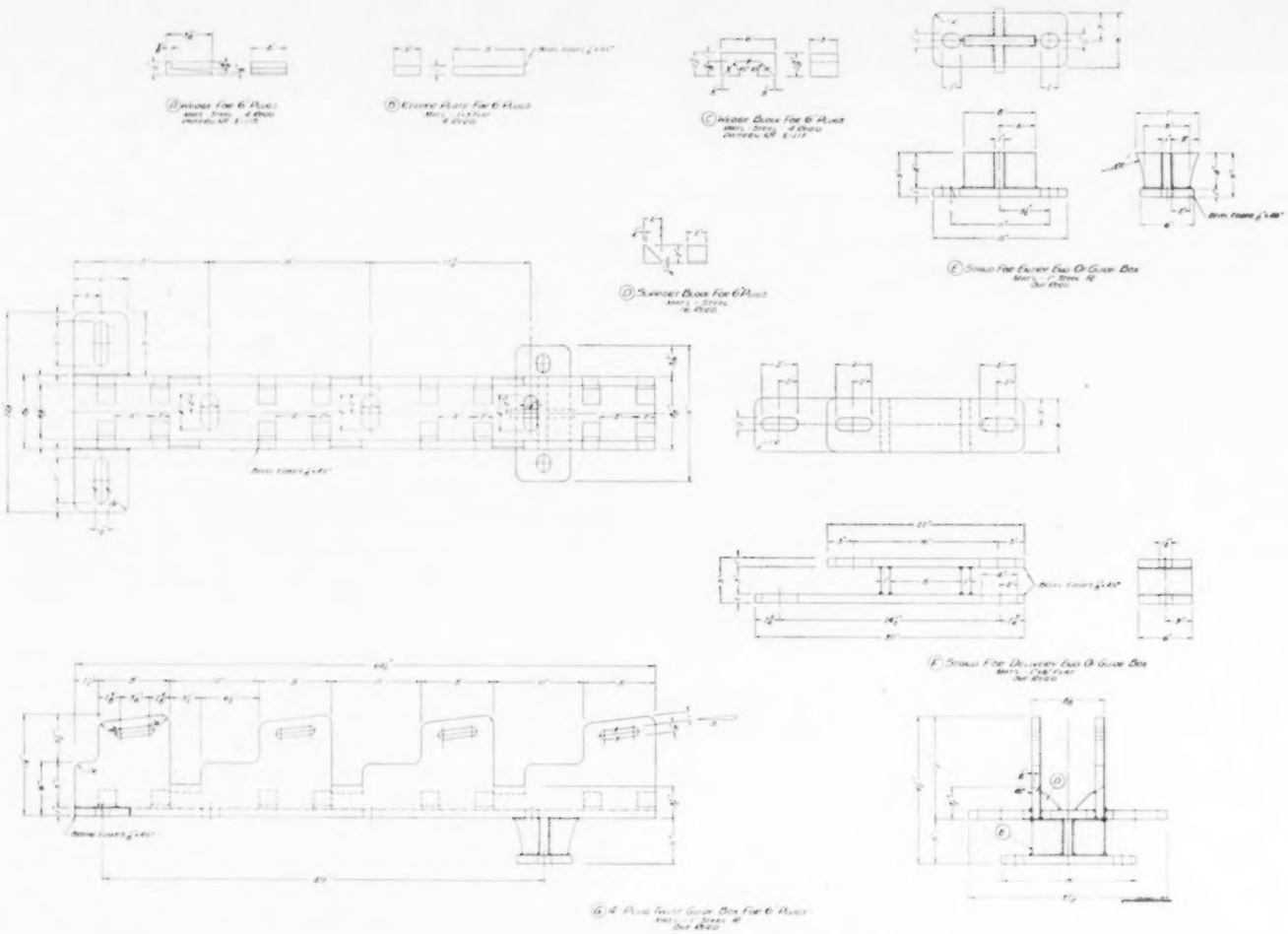


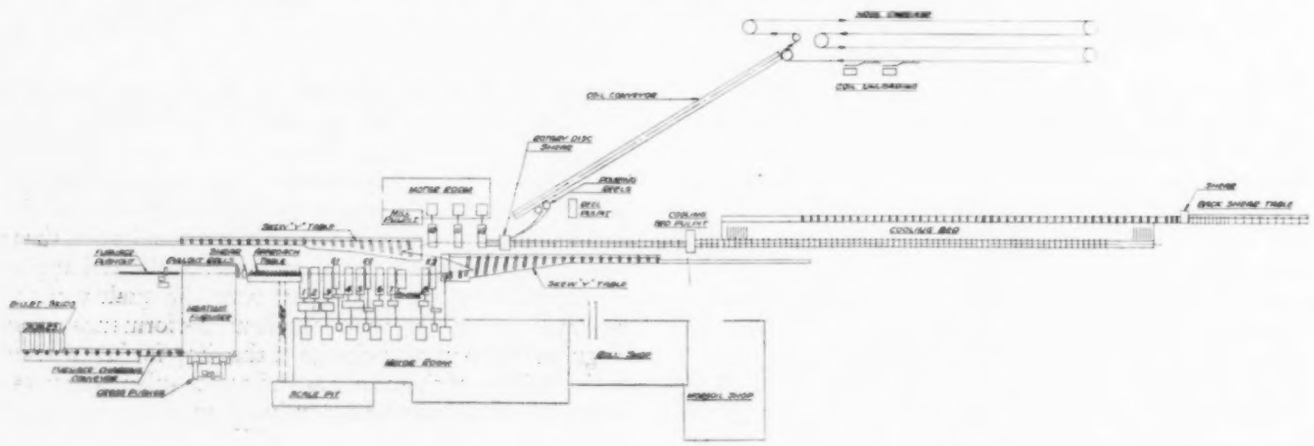
**Figure 4 — 4-plug twist guide box for 6-in. plugs for angles and flats delivering out of No. 8 stand.**

These bearings do not wear because an oil film always separates the journal from its enclosing sleeve. This makes for accuracy and uniformity of product. For instance, when 2 × ⅛ in. angles are rolled from a 2¾-in. billet 30 ft long weighing 750 lb it is necessary to divide this billet, by the shear ahead of the mill, into three lengths each of 10 ft. Repeated measurements reveal that the variation in the thickness of the legs is only 0.002 in. from the front end of the first piece to the back end of the third piece. The straightening of these angles is much easier when the thickness can be maintained so uniformly.

In rolling we can hold constantly to a 0.001 to 0.002 in. variation up and down, but we have found that if the stock is not properly drafted in the roughing mill the round will not be within standard tolerance on the sides.

The original mill was not designed for repeating angles mechanically. Considerable time and worry was experienced in trying to work out our problems for

**Figure 5 — Layout of 12-in. mill at Sheffield Steel Corp. at Kansas City, Mo.**



repeating angles. On Figure 1 we show what we call two strip repeaters designed for the repeating of strip. These repeaters are made to order for repeating angles by the plug twister method we have developed. We believe it is essential for good operations to have variable speed motors to control the length of the loops. It has been found that in changing the thickness of the angles, it is necessary to get a very fine adjustment of speeds to get satisfactory results on the loops. This strip repeater is so designed as to allow the back end to be raised by an air cylinder controlled from the mill pulpit, thus allowing the loop to grow when getting section. After getting section, the speeds are so adjusted that the loop has plenty of freedom in the 30-in. clearance between the front and back end of the repeater.

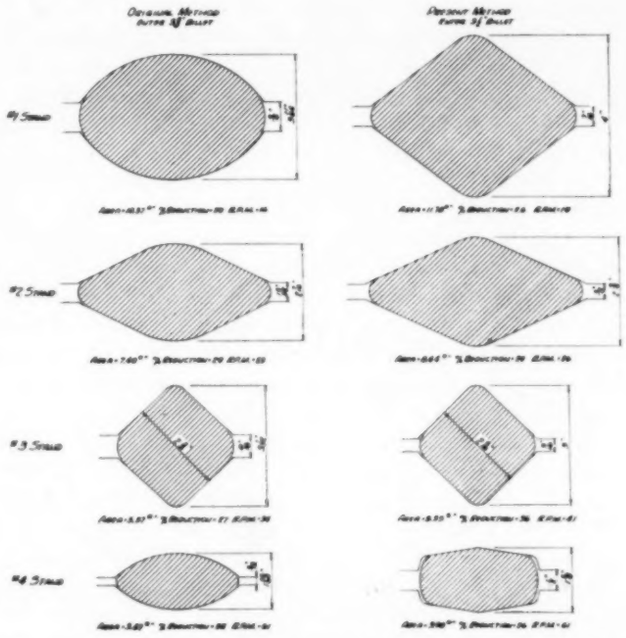


**Figure 6 — Sketch shows original and present method for roughing 1-in. rounds.**

Note on Figure 1 that we show the number of plug twisters used between Stands No. 8 and No. 9 and between No. 9 and No. 10. We show seven plugs after the bar leaves No. 3 edger, and the only reason for using seven was that we had quite a distance to travel and we filled this gap with twister plugs.

We believe that three or four plugs would be sufficient for turning the bar. We use three plug twisters entering No. 9 stand and four plug twisters delivering from No. 9 stand, and three plug twisters entering No. 10 stand. It is our opinion that for satisfactory results it is necessary to have a strip repeater that will not allow the bar to jump out of the repeater when a certain amount of force is needed to push the bar through the twister plugs on the entering side of the mill.

For rolling angles, the passes are all open including the leader pass using nine shape passes and three edging passes.

This is a very economical and conservative roll lay-out, due to the fact that all of the pass sizes are in one set of rolls with the exception of the leader and finishing. The leader takes two sets and the finishing takes three sets to complete the range. The mill uses 18 sets of rolls

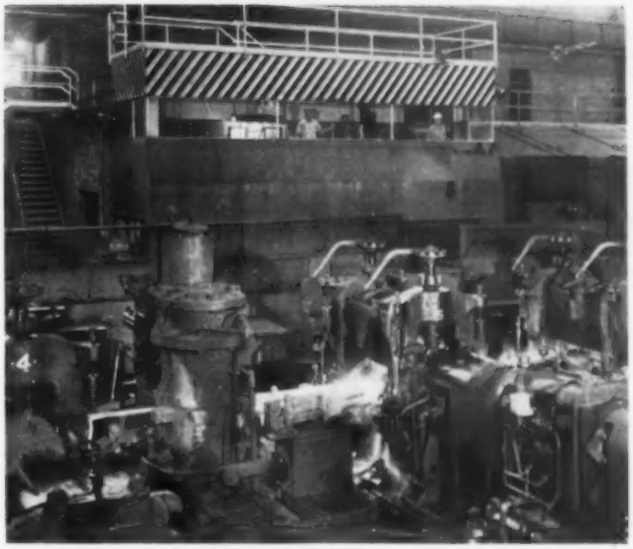
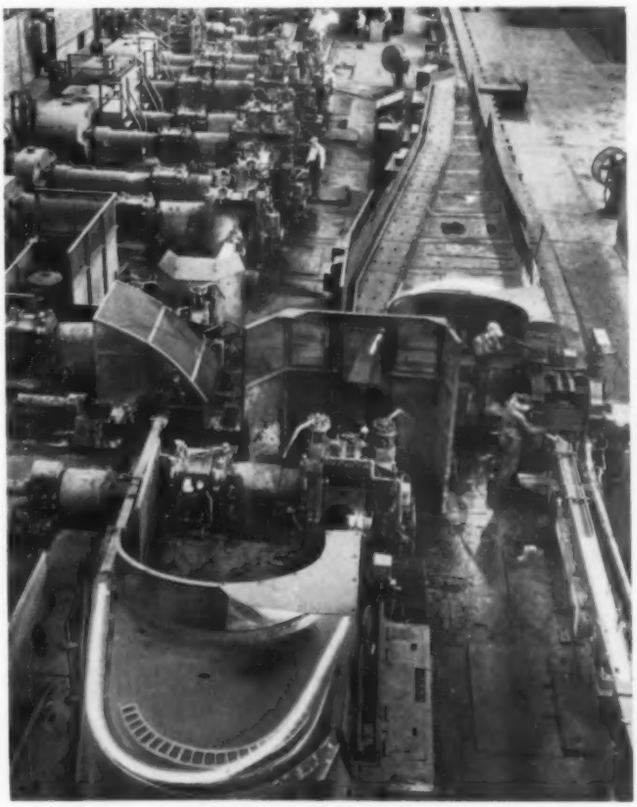


**Figure 7 — Shown in this figure are Stands No. 4, 5 and 6 which are located directly in front of the pulpit.**

in the No. 3 overhung edger to cover the entire range. The roller must take extra care in setting his guides accurately to govern the size of the angle being rolled. To do this, the roller uses wooden templates that are shaped to the exact hot rolled width needed for each size angle being rolled. These templates are approximately 18 in. long, about $1\frac{1}{2}$ in. thick tapering down to $\frac{1}{4}$ in. on the front end.

Some of our best turns on angles are as follows: for $1\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{16}$ in., we produced in three eight hour turns an average of 54 net tons per hr; $2 \times 2 \times \frac{1}{4}$ in.

**Figure 8 — Record output for this mill in one month was 20,048 net tons.**



angles we produced in two eight hour turns an average of 69 net tons per hr.

Our record month to date of coiled rods, merchant and deformed rounds and angles is 20,048 net tons, rolled in 433¼ operating hours for an actual output of 370 net tons per turn and a weighted average of 2.65 lb per ft. This tonnage was rolled onto a single sided cooling bed and most of it sheared to customers ordered lengths on the one shear.

The latest in safety devices were installed and this mill has an ideal arrangement for the safe accommodation of visitors. There are stairs and ramps leading to a large observation platform over the mill pulpit and opposite to the repeaters, giving a bird's-eye view of the entire rolling process from the furnace to the cooling bed or reels. During open house in June of 1951, 3650 people were ushered through these observation areas in one evening. This mill has been judged by visitors from other plants as being one of the tidiest mills ever visited; credit should be given to the supervisors and employees of the department.

We realize that there are many fine rolling mills throughout the country, but we feel we have good reasons to be pleased with our 12-in. mill and look with enthusiasm to further possibilities as time marches on.

# DISCUSSION

PRESENTED BY


**WILLIAM HERMAN, Superintendent Rolling Mills, Keystone Steel & Wire Co., Peoria, Ill.**

**A. H. GRIFFITHS, Superintendent of Rolling Mills, Kansas City Plant, Sheffield Steel Corp., Kansas City, Mo.**

**A. F. EISEL, Chief Roll Designer, United Engineering and Foundry Co., Pittsburgh, Pa.**

**W. W. KNIGHT, JR., Engineer, Morgan Construction Co., Worcester, Mass.**

**P. T. REYNOLDS, Roll Designer, Republic Steel Corp., Massillon, Ohio.**

**C. P. HAMMOND, General Superintendent, Green River Steel Corp., Owensboro, Ky.**


**William Herman:** Practically all of your stands are being driven by individual motors. Do you experience any trouble in speed relationship from stand to stand when you use two bars in the mill or do you never use two?

**A. H. Griffiths:** No sir, we do not.

**William Herman:** You mentioned the roof for your furnace, and say it is a suspended roof. Is this a brick roof suspended on hangers or is it a ram type roof where you use a ram material?

On your motors, what kind do you use? Are they d-c?

It is interesting to note too that you use rounds, that you have taken your squares out and used rounds. We had a similar proposition on the old merry-go-round bloomer that we have, where we put a square around the 25-ft diam circle and it did the same thing, it turned in the pass. So we went to a round for the same reason.

**A. H. Griffiths:** We have a suspended brick roof. It was the first of the type that was put in operation. We have had it now for three years and have had wonderful results with it.

We use direct current on our motor and we only run one single strand at the present time, but the mill is designed for two strand rolling.

**A. F. Eisel:** In the rolling of angles, do you or do you not use a closed pass in the leader?

**A. H. Griffiths:** All our passes are open.

**A. F. Eisel:** Including the leader?

**A. H. Griffiths:** Yes. You notice we mention only up to an inch and a quarter. If we roll anything below an inch and a quarter we intend to have closed passes for about three passes back.

**A. F. Eisel:** It is a little difficult to hold those small sizes?

**A. H. Griffiths:** That is right.

**W. W. Knight:** I want to say that on this 12-in. merchant mill, provision has been made for the future rolling of small sections double strand.

**P. T. Reynolds:** We were wondering whether the vertical edgers were used on all types of products, and also if the use of the plugs were any particular nuisance, or if the split ends cause any trouble going through the plugs?

**A. H. Griffiths:** In answer to your first question, we use the edgers on angles and flats but not on rounds. We were having trouble with split ends, on 1 and 1⅛-in. rounds when we first started the mill, and at that time it was necessary to crop between Stands No. 6 and 7. Trying to run at a fast rate of speed we would cut off a large size crop so we thought of the idea of changing our first pass from an oval to a 102 degree diamond, and our No. 2 pass to a 130 degree diamond.

In the picture, you saw the 3½-in. billet being turned on the table as it entered the first stand of the rolls. We found that it was necessary to have this billet enter on a diagonal, in other words, enter straight and not to have it necessary to flip, because if it flipped at all, we had a bad end, but by holding the billet up on the diagonal, we were able to control very successfully without the need of cropping and were able to get the bar on the hot bed without trouble from split ends.

**Charles P. Hammond:** Is it possible to use the strip repeaters on ordinary sections such as squares or rounds?

**A. H. Griffiths:** I think it would be possible to use the strip repeaters, but the strip repeater gets quite a little abuse. We feel that for rolling, and we have two or three weeks rollings of rounds at one time, we feel that we would like to take the strip repeaters out and put in the conventional round repeaters, and probably not abuse the strip repeaters quite so much. We have not tried it, but I would not try to roll angles with the conventional round repeater, because we feel that it is necessary to have a backing when you are turning the bar to push it through the plugs. However, I do not see any reason why we could not use the strip repeaters for rounds, if necessary, if we want to keep from changing repeaters on a short order.

**A. F. Eisel:** I might add a few thoughts to the remarks regarding the plugs. The author mentioned the fact that he used seven to fill up the gap, and he could possibly get away with three or four. Well, I would like to tell him that we have in operation a 12-in. mill using two plugs, repeating the angle around the repeater, also repeating the square around the same repeater which has a straight back.

# *Mercury Arc Rectifiers*
# FOR MAIN ROLL DRIVES

By H. E. LARSON
Steel Mill Division
General Electric Co.
Schenectady, N. Y.

***. . . . rectifiers have been used with success in the United States on some continuous mills . . . . in Europe they have been used on some single stand reversing mills and in the future such applications may be tried here . . . .***

▲ MERCURY-ARC rectifiers are not new to the steel mills of the United States. The first rectifier installed in a steel mill in the United States was a 1000-kv multi-anode, single-tank unit installed in 1937 at the South Chicago mill of the Republic Steel Corp. It is still operating, supplying 250-volt constant potential power to the wire mill.

Mercury-arc rectifiers for main roll drives are also not new. At the National Tube Co., Gary, Ind., a 3500-kw and a 1500-kw rectifier have each been supplying power to the main roll motors of respective tube mills since 1949. The main drive of a new "Assel" type tube mill being built for the Republic Steel Corp., South Chicago, Ill., will be supplied from a 1200-kw pumpless unit substation type rectifier.

Several papers on mercury-arc rectifiers have previously been presented. In 1940 at the AISE Annual Convention, L. A. Umansky presented a paper, "Application of Power Rectifiers to Main Roll Drives," 1941 Proceedings AISE, p 269. This and other papers have described rectifiers and their operation. It will not be the purpose of this paper to describe the necessary components, method of operation, phase control, and all operating characteristics of rectifiers. Rather, this paper will endeavor to present simply:

1. Progress that has been made since 1939 in the application of rectifiers to main roll drives.
2. Basic proven reasons why rectifiers are favored over motor-generator sets for certain classes of mills.
3. Inherent limitations of rectifiers.
4. Developments in rectifier equipments that have helped accelerate their application and improve their performance.
5. Three classes of mills to which rectifiers have been and might be applied.
6. Problems that have been solved and still remain to be solved when applying rectifiers to these three classes of mill drives.

Table I is a summary of known applications of rectifiers to main roll drives since 1939, when the first two units were purchased by Weirton Steel Co. Table I shows that considerable progress has been made by U. S. electrical manufacturers, especially from 1949 to date, in the application of rectifiers to main roll drives both in the United States and in foreign countries. This is borne out by the following facts derived from Table I:

1. Previous to 1949, rectifiers applied to main roll drives totalled 12,500 kw.
2. From 1949 to date the totals are:
   a. In the U. S. . . . . 87,700 kw.
   b. In foreign countries —
      by U. S. manufacturers . . . . . 48,000 kw.
   c. Total built by U. S. manufacturers . 135,700 kw.
3. According to classes of mills, the 148,200 kw total of Table I breaks down as follows:

| | |
|---|---|
| Hot strip mills | 132,000 kw |
| Tube mills | 7,700 kw |
| Skelp mills | 6,000 kw |
| Merchant mills | 2,500 kw |

4. The bus capacity of four hot strip mills has been increased by adding rectifiers to operate in parallel with existing motor-generator sets rather than additional motor-generator sets.
5. Pumpless type rectifiers (a recent development) have been applied to three mills totalling 13,200 kw.

Aside from the substantial progress in quantity that the above figures show, it is of interest to note that:

1. Rectifiers are now an accepted type of conversion equipment for the d-c main roll drives of hot strip mills.
2. The pumpless type of rectifier construction is gaining favor.

TABLE I

Mercury Arc Rectifiers Supplying Steel Mill Main Roll Drives

| Item No. | Purchaser and location | Application | Year installed | Rectifiers | | | |
|---|---|---|---|---|---|---|---|
| | | | | Units-kw | Total kw | D-c volts | Mfgr. |
| 1. | American Steel & Wire Co., Cleveland, Ohio | 10-in. Hot strip mill | 1942 | 1-3000(1) (7) | 3,000 | 600 | West. |
| 2. | Kaiser Co., Fontana, Calif. | Merchant mill | 1943 | 1-2500(8) | 2,500 | 600 | West. |
| 3. | Weirton Steel Co., Weirton, W. Va. | 66-in. Hot strip mill | 1946(2) | 2-3500(1) | 7,000 | 600 | G.E. |
| 4. | Kaiser Co., Fontana, Calif. | 86-in. Hot strip mill | 1949 | 2-5000 | 10,000 | 600 | G.E. |
| 5. | National Tube Co., Gary, Ind. | Continuous tube mill | 1949 | 1-1500 | 1,500 | 600 | G.E. |
| 6. | National Tube Co., Gary, Ind. | Continuous tube mill | 1949 | 1-3500 | 3,500 | 600 | G.E. |
| 7. | Bethlehem Steel Co., Lackawanna, N. Y. | 79-in. Hot strip mill | 1950 | 1-4000(1) | 4,000 | 600 | West. |
| 8. | Denain Et D'Anzin, France | 66-in. Hot strip mill | 1950 | 3-5000 | 15,000 | 700 | West. |
| 9. | Detroit Steel Corp., Portsmouth, Ohio | 54-in. Hot strip mill | 1951 | 2-5000 | 10,000 | 750 | G.E. |
| 10. | Sollac, France | 80-in. Hot strip mill | 1952 | 3-6000 | 18,000 | 700 | West. |
| 11. | Austrian Iron & Steel, Austria | 56-in. Hot strip mill | 1952 | 3-5000 | 15,000 | 700 | West. |
| 12. | Armco Steel Corp., Middletown, Ohio | 80-in. Hot strip mill | 1952 | 1-5000 | 5,000 | 600 | West. |
| 13. | U. S. Steel Corp., Morrisville, Pa. | 80-in. Hot strip mill | 1952 | 6-4000 | 24,000 | 700 | West. |
| 14. | Pittsburgh Steel Co., Allenport, Pa. | 66-in. Hot strip mill | 1952(3) | 2-5000 | 10,000 | 600 | G.E. |
| 15. | Republic Steel Corp., So. Chicago, Ill. | Seamless tube mill | 1952(3) | 1-1200(5) | 1,200 | 600 | G.E. |
| 16. | Ohio Seamless Tube Co., Shelby, Ohio | Seamless tube | 1952(3) | 1-1500 | 1,500 | 600 | West. |
| 17. | National Tube Co., Morrisville, Pa. | Skelp mill | 1953(3) | 2-3000(5) | 6,000 | 600 | G.E. |
| 18. | Great Lakes Steel Corp., Ecorse, Mich. | 96-in. Hot strip mill | 1953(3) | 1-6000(1) (4) | 6,000 | 600 | G.E. |
| 19. | Kaiser Co., Fontana, Calif. | 86-in. Hot strip mill | 1954(3) | 1-5000(6) | 5,000 | 600 | G.E. |
| | | | | | 148,200 | | |

SPECIAL NOTES:

(1) Rectifiers operate in parallel with motor-generator sets.
(2) Rectifiers purchased in 1939 — not installed until after World War II. First rectifier to be built for domestic hot strip mill.
(3) Not yet installed — being built.
(4) Pumpless rectifier tanks.
(5) Pumpless rectifier tanks, close connected, unit sub-station construction.
(6) Third unit added to first two of item (4).
(7) First unit to be installed for domestic service.
(8) Later changed to hot strip mill.

## BASIC REASONS WHY RECTIFIERS ARE FAVORED OVER MOTOR-GENERATOR SETS FOR CERTAIN CLASSES OF MILL DRIVES

For supplying d-c power to the main roll drives of non-reversing, infrequently accelerated continuous mills, rectifiers in actual service have demonstrated their reliability to be equal if not superior to motor-generator sets. Reliability of the power supply for a hot strip mill, as an example, which may roll as much as $20,000 of salable strip per hour is of prime importance. Developments in rectifiers discussed later have considerably improved rectifier reliability and performance. Nobody speaks any more of arc-backs as affecting reliability of performance — automatic-reclosing high-speed anode breakers take care of these without the mill operators knowing that they do occur occasionally. Reliability no longer affects the choice between rectifiers and motor-generator sets.

The choice today is rectifiers over motor-generator sets for continuously running mills, infrequently started and stopped because of these advantages that rectifiers enjoy:

1. Lower equipment cost.
2. Lower losses, resulting in power savings.
3. Lower installation cost.
4. Lower maintenance cost.
5. Higher momentary overload capacity.
6. No fault contribution to the a-c system.

Rectifier equipments 500 volts d-c and higher, usually cost from 5 to 15 per cent less than motor-generator set equipments. Rectifier equipments include their transformers, rectifier auxiliaries, a-c and d-c switchgear. Motor-generator set equipments include their ventilating equipment, a-c and d-c switchgear. For two 5000-kw equipments, the price of a rectifier equipment may be from $75,000 to $100,000 less than that of the motor-generator set equipment — bus and motor breakers not included.

The lower losses of rectifiers are shown in Figure 1. For a 500-kw, 600-volt unit, Figure 1 shows the full load loss of the rectifiers to be approximately 260 kw less and the no load loss approximately 220 kw less than the motor-generator set. Considering only the reduction in no load loss, the saving in kwhr for a 5000-kw unit is over 1,500,000 kwhr during a 7000 hour year. For a 15,000-kw rectifier installation with power at 0.7 cents per kwhr, an annual saving of over $30,000 can accrue.

The rectifier costs less to install because it does not require any heavy foundations, since it is a static machine and relatively light in weight. Further, less motor room ventilating equipment is required for the rectifier as it is water-cooled. The transformer can also be water-cooled or can be self-cooled mounted outdoors, as is frequently done to conserve motor room space. For these reasons, the total cost of installing a rectifier equipment may easily be from 10 to 30 per cent less than the cost of installing a motor-generator set equipment.

The rectifier costs less to maintain since it has no commutator to stone or brushes to sand and replace. It does not have to be blown out each downturn, nor

periodically revarnished. It does have a heat exchanger that must be kept clean and certain accessories that require periodic inspection. At rare intervals, igniter tips have to be replaced. Users having both motor-generator sets and rectifiers enthusiastically report savings in maintenance costs for the rectifiers of from 33 to 50 per cent.

The higher momentary overload capacity of the rectifier is something users learn to appreciate and value. Having no commutator, the amount of overload that a rectifier can take, as shown in Figure 2, is a function of time. A rectifier can even be short circuited briefly without damage or apparent distress. A motor-generator set, on the other hand, is usually limited to peaks of 200 per cent load for one minute, and loads much higher than this will cause undue wear on commutator and brushes and may even result in flash-over.

The fact that a rectifier contributes no current to a fault on the a-c system is usually not fully appreciated until a short circuit study is made. Three 5000-kw synchronous motor-generator sets will contribute over 100,000 kva since the synchronous motors act like generators on system faults. The use of rectifiers results in reduced interrupting duty on a-c primary breakers, if not in smaller breakers or for a given rating of breakers, the reactance of transformers feeding the plant need not be as high as with synchronous motor-generator sets, resulting in improved voltage regulation.

## INHERENT LIMITATIONS OF RECTIFIERS

Rectifiers do have some inherent limitations which must be recognized even when applying them to non-reversing continuous mills which accelerate infrequently. For reversing mills, the rectifier's inability to regenerate power seriously handicaps it. The principal limitation of rectifiers that cannot be ignored are:

1. Lagging power factor.
2. Interdependence of a-c system voltage and rectifier d-c voltage.
3. Expense of obtaining voltages below rated for continuous operation.
4. Inability to regenerate power without switching or use of two rectifiers.

The lagging power factor characteristics of a typical rectifier at various loads and rated 600 volts is shown in Figure 3. Figure 3 also shows the power factor still more lagging at reduced voltages of 450 and 300 volts obtained by phase control. Phase control is normally employed during split bus operation and infrequent starting of a group of motors. The power factor of a rectifier cannot be easily modified from these characteristics within the rectifier itself. However, the lagging reactive kva drawn from the power system during starting a group of motors will be of the same order of magnitude as that during operation at normal load and voltage.

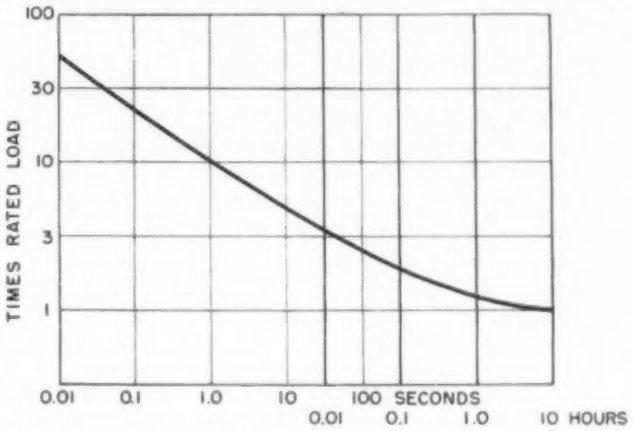
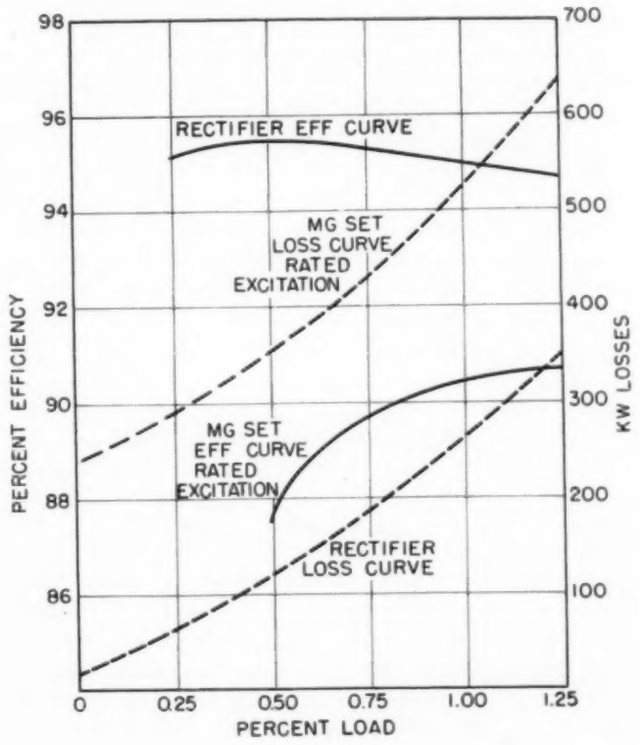



**Figure 2 — Momentary overload characteristics are given for a mercury-arc rectifier.**

**Figure 1 — Comparison of efficiencies and losses of a rectifier and motor-generator set, each rated 5000-kw, 600-v, d-c.**




These characteristics of Figure 3 suffer by comparison with those of synchronous motor-generator sets, which usually operate at unity or leading power factor at rated voltage and load. As the voltage of the d-c generators is reduced, the leading kva supplied to the a-c system by the synchronous motor increases unless a regulator is employed to hold it constant to minimize system voltage variations.

The d-c output voltage of an *unregulated* rectifier varies directly with variations in the a-c system voltage. The lagging kva drawn by rectifiers operating at momentary overloads or at reduced voltage by phase control tends to aggravate the variations in the a-c system voltage. The voltage regulators of rectifiers in holding constant the d-c output voltage must therefore have at their disposal sufficient range by phase control to compensate for not only the inherent voltage regulation of the rectifier equipment, but also whatever variations will be encountered in the a-c supply voltage. On rectifiers for main roll drives, it is usual to design the transformer to deliver sufficient anode voltage to give rated d-c bus voltage with 95 per cent a-c voltage applied

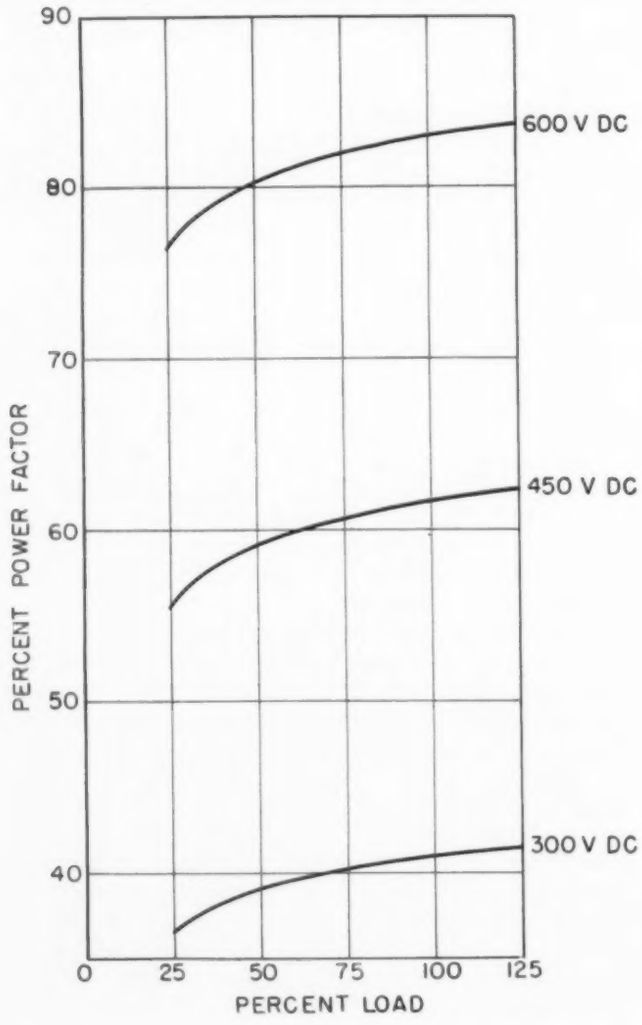
to the 100 per cent a-c primary winding tap when the d-c load peak is the maximum expected, usually taken at 160 per cent for hot strip mills. Sufficient phase control is included to enable the regulator to hold rated bus voltage for higher values of a-c voltage up to 105 per cent and lesser d-c loads.

The d-c output voltage of synchronous motor-generator sets is not affected by small variations in the a-c primary voltage which can even be minimized by using power factor regulators controlling synchronous motor excitation. Generator voltage regulators need compensate only for inherent generator voltage regulation plus any minute system frequency changes that may occur.

As basic as all this is, there have been cases where rectifiers have been applied to hot strip mills in foreign countries where the power systems have proved to be so weak, that after the rectifiers were almost built and voltage regulation studies made, synchronous condensers have been added to bolster the voltage regulation of the a-c system. These were found to be necessary despite the use of synchronous motors on the roughing stands. Obviously, for these conditions, motor-generator sets would have proved more economical.

The d-c voltage of a rectifier is commonly varied smoothly by phase control alone from practically zero to rated voltage during the occasional starting of a group of motors. However, as shown in Figure 3, a low voltage means low power factor in direct proportion. Also, the interphase transformer heating limits the time of operation at reduced voltage by phase control. For these reasons, phase control over an appreciable voltage range is not considered practicable on large rectifiers for purposes other than occasional motor starting service of short time duration.

**Figure 3 — Power factor of a 5000-kw, 600-v rectifier is given for rated and reduced voltage conditions.**




When a rectifier must operate at reduced voltage levels *continuously*, transformers with suitably tapped extended primary windings or regulating auto transformers to cover the range are provided. No-load tap changing systems, which are relatively inexpensive, require that the mill be shut down long enough to select the proper tap and then restarted. If it is desired to change taps without stopping the mill or under load, then more expensive load ratio control equipment must be included in the transformer.

The ability of the motor-generator set and the inability of the rectifier to regenerate power without switching is well known. Rectifier equipments can be modified to regenerate power in one of two ways: (1) reversal of the direct current power circuit and converting the rectifier to an inverter, or (2) by the use of two rectifiers, one of which supplies power when the motors are running in the forward direction and, by means of excitation system changes, absorbs power when the motors are decelerating from the reverse direction; the second rectifier supplies reverse power and regenerates forward power. Neither arrangement has yet been used on the main roll drive of a reversing or frequently accelerating mill in the United States, though both arrangements are reported to be in successful operation in Europe.

## DEVELOPMENTS IN MERCURY-ARC RECTIFIER EQUIPMENTS

In presenting developments that have been made since 1940 in rectifier equipments, this paper of necessity is limited to those with which the author is familiar; others, no doubt, have also made developments and improvements in rectifier equipments.

Each of these developments has contributed to the general acceptance and now preference by mill operators for rectifiers where they can be used to advantage. The combined impact of these developments has been improved operation, increased reliability, reduced maintenance, and simpler installation of rectifiers for main roll drives. Since each development is otherwise unrelated, they are considered below as separate subjects:

### AMPLISTAT VOLTAGE REGULATOR

The amplistat voltage regulator for power rectifiers was first presented to the AISE in October 1949. See "A Static Magnetic Amplifier for Regulating Circuits," by H. E. Larson and T. Dunnegan, Jr., 1950 AISE Proceedings, p 405. It is a self-saturating magnetic amplifier — an entirely static device requiring minimum maintenance and having a high speed of response. The entire amplistat voltage regulating system is shown in Figure 4 mounted on the inside of the door of the

excitation compartment. On the panel in the compartment is the excitation and firing equipment, also static. It is noteworthy that voltage regulation and firing control of a rectifier are now accomplished entirely with static devices requiring minimum maintenance.

The amplistat regulates the bus voltage at all times (even during acceleration from rest) against a standard such as the voltage from a potentiometer type motor-operated rheostat by varying the excitation of the saturating windings of the phase shifting reactor. Figure 5 shows a recording voltmeter chart with biased scale of bus voltage as metal passes through the four finishing stands of an 86-in. hot strip mill supplied from

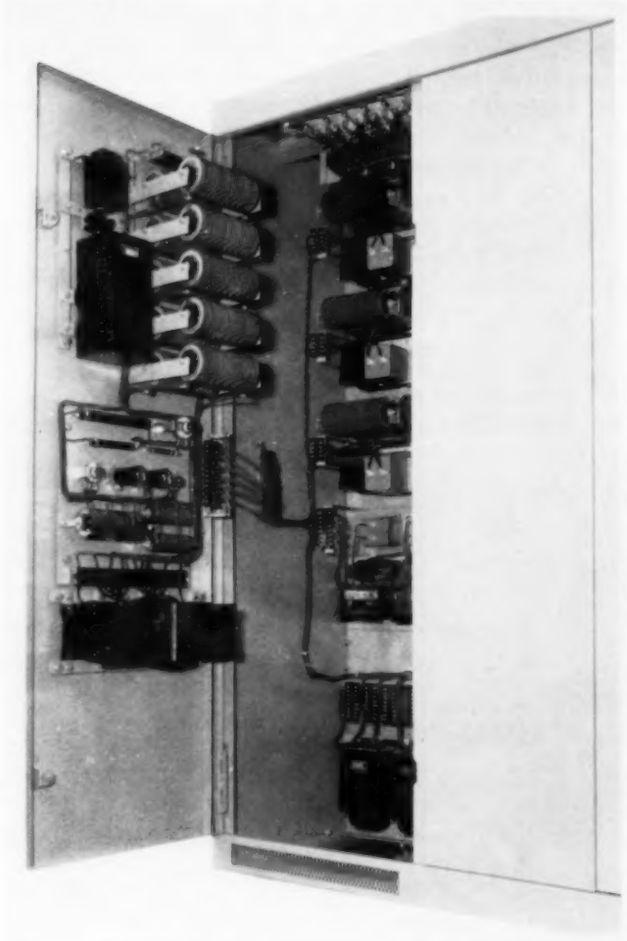


**Figure 4 — Amplistat voltage regulator for rectifiers is mounted on door of excitation compartment.**

two 5000-kw rectifiers. The chart shows that voltage always recovers in approximately ½ second with an averaged drop of only 3 volts.

Because the amplistat itself has a high speed of response and also because a rectifier has a higher speed of response than a d-c generator, rectifiers controlled by amplistat regulators are well suited for supplying power to split bus sections of continuous rolling mills and even to individual stand motors without the use of a bus.

The amplistat also regulates load division between two or more rectifiers connected to a common bus. The signal of power current flow for load division purposes is simply taken from the 100-mv meter shunt — no power consuming dropping resistors are used. This

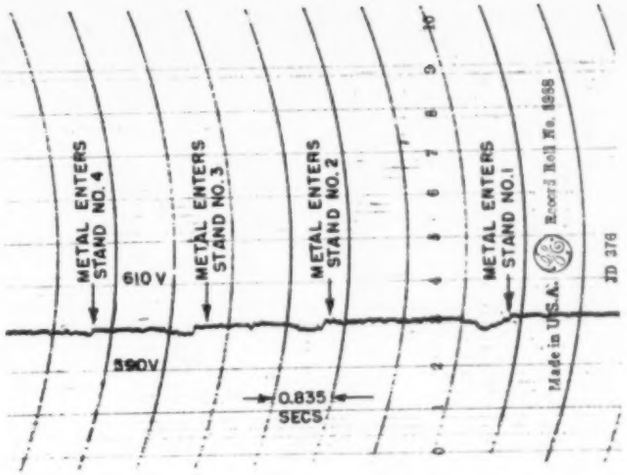



**Figure 5 — Recording voltmeter chart shows constancy of voltage for 86-in. hot strip mill bus supplied by two 5000-kw amplistat regulated rectifiers.**

signal is amplified in an amplistat preamplifier, then fed to the equalizer control winding of the main voltage regulating amplistat.

## PUMPLESS RECTIFIER CONSTRUCTION

Rectifiers may be continuously evacuated or pumped during operation or they may be pre-evacuated and operate pumpless. Pumped type rectifiers are well known, but pumpless rectifiers are fairly new.

A rectifier with six pumpless tanks has been operating since October 1948 without any significant loss of vacuum — others have operated with similar results for shorter periods of time. The success of pumpless rectifiers has been so marked that they are becoming almost generally accepted, even for main roll drive service.

The advantages of the pumpless over the pumped

**Figure 6 — Pumpless rectifier is shown in enclosure with built-in tank hoist and one tank swung out.**

rectifier are fairly apparent from an inspection of Figure 6. These are:

1. Possible leaks are reduced because vacuum headers, connections and indicators are eliminated.
2. The reliability of the rectifier is not dependent on the reliability of the vacuum pumps.
3. Rectifier tanks can be assembled in two tiers in unit substation type enclosures.
4. A reconditioned tank is easily installed when necessary in about 30 minutes.
5. Maintenance cost is reduced because constantly running vacuum pumps are eliminated.

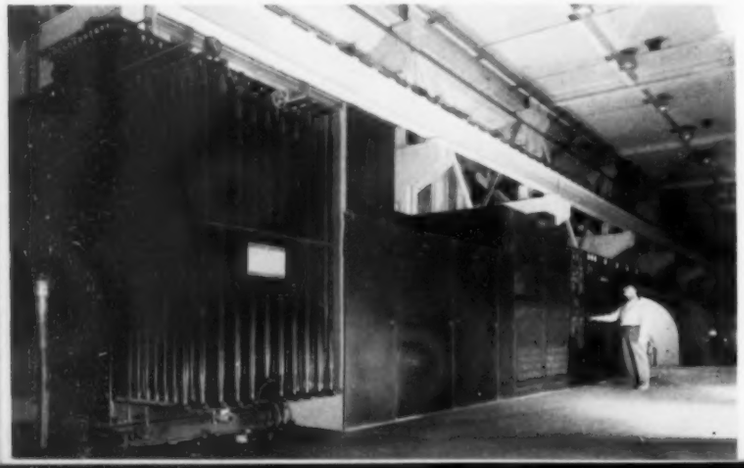
**Figure 7 — Storage unit for spare pumpless rectifier tank.**

Despite the sealed construction, the user need not be dependent on the manufacturer for conditioned tanks. Figure 7 shows a spare tank in a user's storage unit, ready to be placed into service when necessary. Even though vacuum is lost in one unit due to the absence of an interconnecting vacuum system, any trouble will be confined to one tank and not spread to the others. Hence, only one spare tank is all that is required.

## RECTIFIER UNIT SUBSTATION TYPE CONSTRUCTION

By rectifier unit substation type construction is meant that shown in Figure 8, which however, does not include the high voltage switchgear usually included and throated to the transformer in a complete rectifier unit substation.

**Figure 8 — Pumpless rectifier unit substation is installed in a steel mill.**



Rectifier unit substation type construction has been employed for years with sealed tube rectifiers. Unit substation construction for pumped type rectifiers has been slowly gaining popularity since the two pumped unit substation type, 1500-kw, 250-volt rectifiers were built for the Gary Steel works of the United States Steel Co. in 1942 (but not then installed). With the advent of the pumpless rectifier, however, this type of construction is now rapidly gaining popularity.

Figure 9 shows in plan and elevation all of the principal components that can be combined into a pumpless rectifier unit substation for main roll drive. This construction results in *lower installation cost* because:

1. All interconnections are included with substation.
2. Rectifier enclosure is furnished — purchaser need not enclose or fence in.
3. Less time is consumed during planning and installation.
4. Compactness results in saving of floor space.
5. Tank hoist for changing tanks is included as an accessory — purchaser need not furnish or install.

## COMMUTATING REACTORS

Commutating reactors are not a new development, but they are included here because their use is somewhat

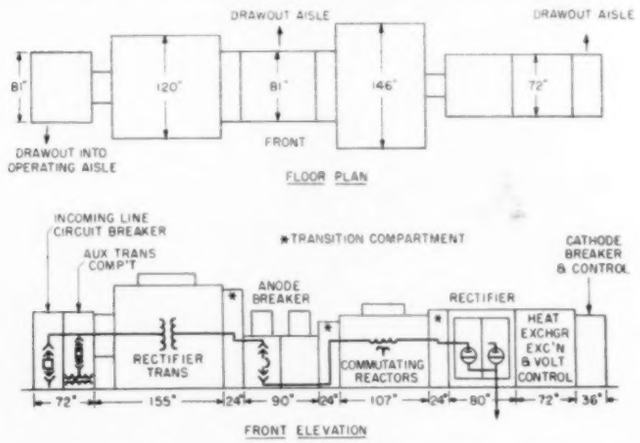



**Figure 9 — Approximate outline is shown for a 3000-kw pumpless rectifier unit substation for main roll drive.**

controversial. They are sometimes included in rectifier equipments for main roll drives furnished by our company.

Figure 10 shows two commutating reactors installed outdoors with the transformer for a 3000-kw, 600-volt rectifier supplying a continuous mill. When the installation requires outdoor type reactors, a reactor element may be inserted in each anode lead between the transformer and the high speed anode breaker for convenience. When the reactors are installed indoors, they may be inserted in each anode lead between the high speed anode breaker and the rectifier.

Commutating reactors are used on rectifiers rated 500 volts and higher and with rectifiers using appreciable amounts of phase control because their use tends to reduce the probability and frequency of arc-backs. It does so by modifying the rate of current transfer

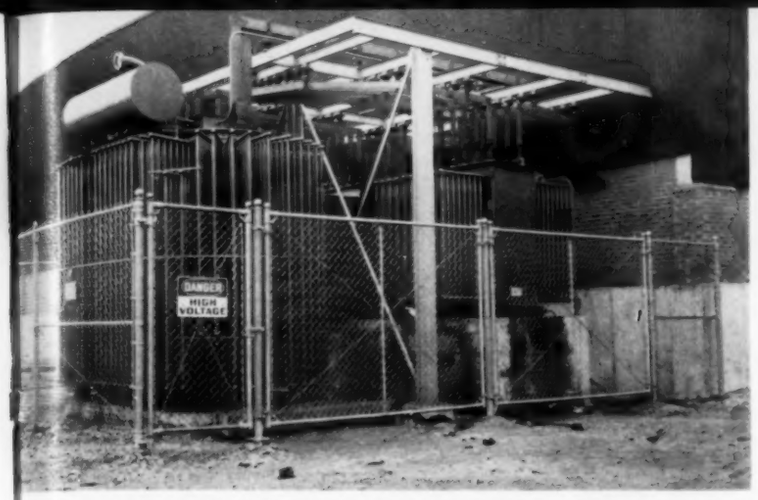



**Figure 10 — Outdoor transformer with two commutating reactors for 3500-kw, 600-v rectifier supplies main drives of continuous tube mill.**

between rectifying tanks. Sustained operation of a rectifier with considerable voltage control by phase retard usually requires derating of the rectifier. The use of commutating reactors eliminates the need for such derating.

Commutating reactors are static devices requiring even less maintenance than the rectifier transformer.

## HEAT EXCHANGERS

The water that cools the rectifier tanks is treated with rust inhibitor and is constantly recirculated. The

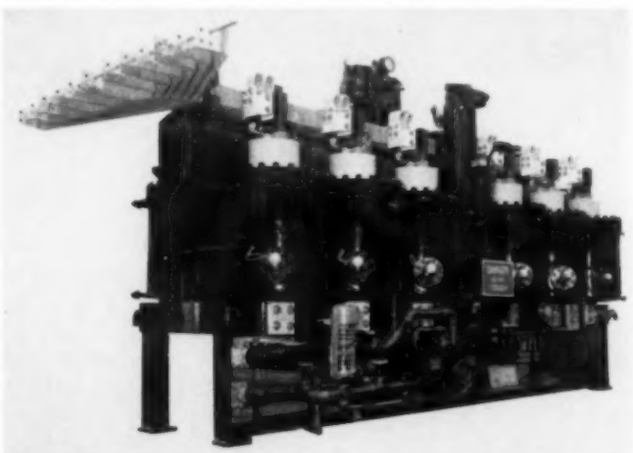


**Figure 11 — Twelve-tank pumped-type rectifier has integral heat exchangers.**

recirculating system includes a heat exchanger which has tubes for the raw cooling water around which the treated water passes.

In the earlier types of pumped rectifiers, large separately-mounted heat exchangers were often used. These were designed to act both as heat exchangers and reservoir for the recirculating treated coolant. Rubber hoses connected the rectifier to the heat exchanger. These were long enough to hold leakage current from the rectifier tanks (at cathode potential) to the heat exchanger (at ground potential) to non-objectionable values. Because of the difference of potential existing across the hoses between rectifier and heat exchanger, some of the recirculated water was continually lost by electrolysis and had to be replenished. The rubber hoses obstructed freedom of movement around the rectifier. The recirculating pump was a separate unit. All this equipment required considerable floor space.

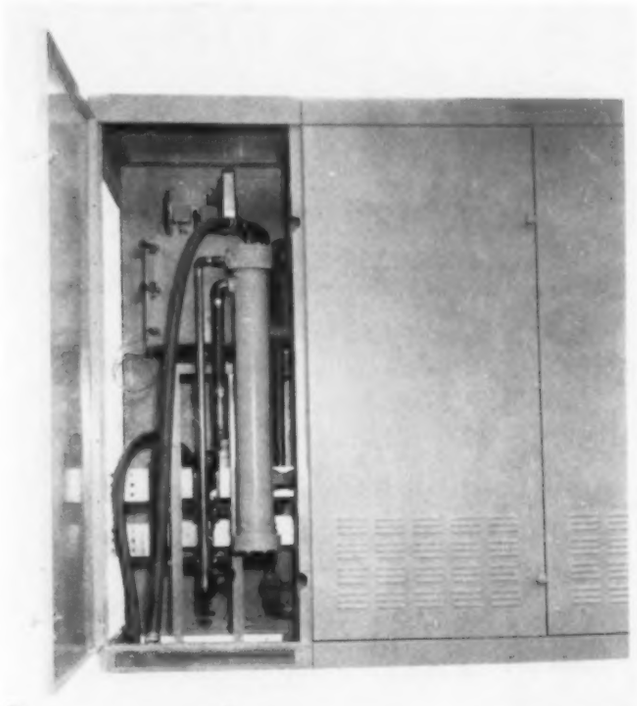
The modern type of pumped rectifier with integral heat exchangers and reservoir is shown in Figure 11. The heat exchangers are built into the base of the rectifier and a separate reservoir with vertical leakproof recirculating pump is located in the center of the tank assembly. Tanks, heat exchanger and reservoir are all at cathode potential, eliminating loss of recirculated water by electrolysis. Special insulating sections are provided for raw water inlet and discharge. In this way, the whole pumped type rectifier has been made more compact, requiring less floor space and lending itself better to unit substation type construction.

The new pumpless type of rectifier, being a metal enclosed unit, has a separate compartment for the heat exchanger and water reservoir, as shown in Figure 12. Despite the enclosure, the heat exchanger can be easily cleaned by removing top and bottom header plates, placing a bucket below, and running flexible cleaning rods down from above. The vertical position facilitates flushing the tubes after rodding. Both the heat exchanger and reservoir in this compartment are at cathode potential.

## LEAKPROOF RECIRCULATING PUMP

The earlier types of rectifiers employed recirculating pumps with packings which were a constant source of annoyance. Figure 13 shows the storage tank for a pumpless rectifier in which the recirculating pump is submerged, driven from the vertically mounted motor on top. Leakage around the shaft of such a pump simply returns to the low pressure reservoir. The pump bearings are lubricated by the treated water and run for years without attention.

**Figure 12 — Heat exchanger is in compartment of unit substation type pumpless rectifier.**



## INCREASE IN IGNITOR LIFE

A demountable ignitor assembly of an ignitron rectifier is shown in Figure 14. It is designed to bring two electrical circuits, one for the ignitor and the other for the auxiliary holding anode, through vacuum tight insulating seals into the vacuum chamber. This assembly also supports the ignitor and holding anode mechanically. A flexible diaphragm is pressed against vacuum tight gaskets when the assembly is bolted in its proper place to the vacuum tank. The boron ignitor tip is immersed about $\frac{3}{8}$ in. at a point near the center of the mercury pool cathode, and the depth of immersion is adjustable by means of the external adjusting screws, permitted by the flexible diaphragm. Each cycle, a capacitor discharge surges through the ignitor tip into the mercury, creating a cathode spot which emits electrons "firing" the rectifier tank.

Life of ignitors has been lengthened by improved mechanical supports, selection of better ignitor material and control of manufacture. It has also been increased by avoiding contamination of the ignitor after it has been assembled in the vacuum tank. Certain types of gasket material amalgamated in the mercury, and had to be avoided; and only chemically pure mercury is safe to use. Average life of ignitors now ranges between 5 and 10 years, even in high current heavy duty rectifiers in continuous service.

## MAINTENANCE-FREE MISFIRE PROTECTIVE SYSTEM

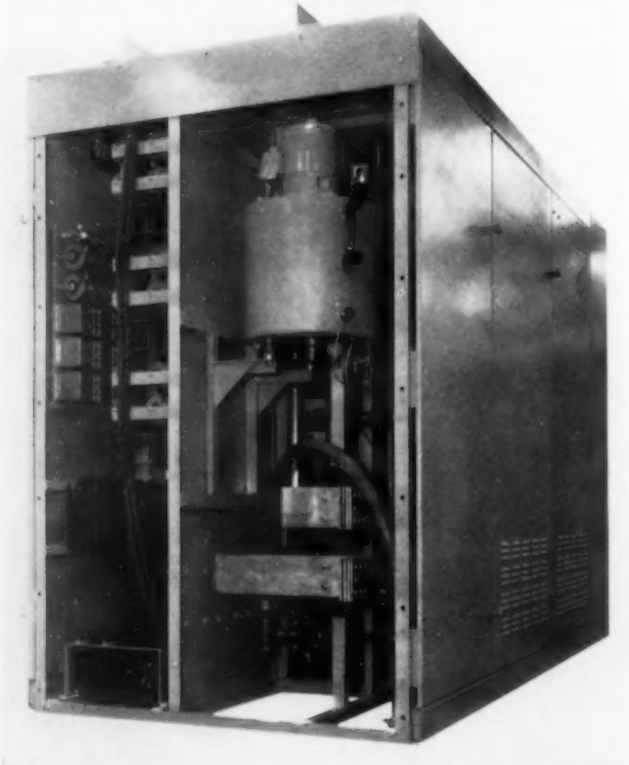
Ignitors occasionally misfire — repeated misfire is usually an indication of mechanical failure of the ignitor tip. Persistent misfire is a condition that must be corrected as otherwise transformers and rectifier tanks may be overloaded.

**Figure 14 — Ignitor and holding anode assembly for an ignitron rectifier tank.**

A well known system uses small, high speed relays connected across the excitation anodes to indicate absence of a cathode spot. Operation of the alarm system is prevented in the case of a single random misfire by integrating the individual relays with a final circuit to introduce time delay. These relays operate only when a misfire occurs, but operate on random as well as repeated misfires. They therefore require periodic inspection and maintenance.

A new misfire protective system has been developed which uses an induction disc type IAC relay with a tuning capacitor supplied from misfire insulating transformers, the primaries of which are connected to a pair of holding anodes displaced 180 electrical degrees. The relay operates only on *repeated* misfires. The rate of persistent misfire required to actuate the relay may be adjusted within limits by changing its time lever setting. Operation of the relay triggers an alarm system reset manually.

**Figure 13 — Storage tank for treated recirculated water has vertical motor on top driving immersed pump. There are no packing glands to leak.**



## IMPROVED HIGH-SPEED DRAW-OUT TYPE ANODE BREAKERS

Arc-backs do occur in rectifiers. The modern rectifier does not arc-back as often as its older antecedents, but it still does happen occasionally despite the improvements that have been made in anode shielding, proper reactances, and the use of commutating reactors. But with the high speed air circuit breakers having automatic reclosing features that have been developed, an arc-back can occur, the breaker open and reclose automatically without any serious disturbance in either the bus voltage or in the performance of the motors connected to it. Further, there is no noticeable effect on the rectifier equipment itself.

High speed cathode breakers are sometimes advocated. However, they do not protect the transformer nor do they preserve continuity of rectifier service as do high speed anode breakers.

The development of the high speed anode breaker with automatic reclosing features (shown in Figure 15) has resulted in a breaker having these features:

1. High speed current directional tripping mechanism operates on the "shift in flux" principle. Reverse flow of d-c current during an arc-back nullifies the flux normally holding the tripping latch in place. No mechanical part moves until the actual tripping of the breaker starts. From current zero to point of release at the high rates of reverse current rise requires about 0.002 sec.
2. Breaker parts are light in weight, contacts are latched in without the use of toggles and are spring opened.
3. Magnetic forces from normal forward currents help hold contacts closed — reverse currents help open them.
4. Bridging contacts are used — not copper braid flexible shunts.
5. Each breaker pole trips automatically and independently on reverse current — each pole is reset from a common motor-operated closing mechanism which can close 1, 2 or 3 poles simultaneously at the same speed.
6. Total time of opening from zero current, through reverse current, then to zero current before reclosing is approximately 0.015 sec.
7. Total time for a reclosing cycle is adjustable from 1 to 3 minutes.
8. Three pole breaker units are of dead-front draw-out construction for safety and convenience during inspection and maintenance.

**Figure 15 — Four 3-pole draw-out type high speed anode breakers used with one 5000-kw rectifier.**

## CLASSES OF MILLS TO WHICH RECTIFIERS HAVE BEEN AND MIGHT BE APPLIED

Rolling mills which have used or might possibly use rectifiers as the source of d-c power for main roll drive motors fall into the three general classes shown in Table II.

Rectifiers are fast becoming the preferred choice for supply of d-c power to Class I mills. Therefore, the requirements of this class of mill will be presented in detail. Special features of rectifiers designed to meet the requirements of Class I mills will be described. Attention is also called to the need for proper breaker selection and bus design because of the high concentration of d-c power attendant to Class I mill installations.

In the United States, rectifiers have not been applied to Class II or Class III mills, but they have been in Europe. The important general requirements of Class II and Class III mills and the reasons why rectifiers are handicapped in meeting these requirements will be subsequently presented.

**TABLE II**

**CLASSES OF MILLS TO WHICH RECTIFIERS HAVE BEEN AND MIGHT BE APPLIED**

**Class I — Continuously running mills infrequently started and stopped.**

- a. Hot strip and skelp mills.
- b. Merchant and rod mills.
- c. Continuous, "Assel," and piercing type tube mills.

**Class II — Single stand reversing mills without reels.**

- a. Blooming mills.
- b. Slabbing mills with edging rolls.
- c. Plate mills with edging rolls.
- d. Reversing roughing mills of semi-continuous hot strip mills with edging rolls.

**Class III — Strip mills with reels frequently accelerated and decelerated and even reversed under load.**

- a. Non-reversing single stand and tandem cold strip mills.
- b. Reversing cold strip mills.
- c. Reversing hot strip mills.

## REQUIREMENTS OF CLASS I — CONTINUOUSLY RUNNING MILLS, INFREQUENTLY STARTED AND STOPPED

Mills of this class run continuously at essentially constant speed as each length of metal is threaded through tandem stands "on the fly." Metal may be in all stands at the same time. Loads on individual stand motors may be adjusted by field control to obtain tension or looping in the metal between stands, but for a given schedule, the average speed of the motors is constant, as is the voltage applied to them.

To meet the requirements of rolling schedules outside the speed cone available by field control, the bus may be split into two or more sections and the mill operated continuously with reduced voltage on some bus sections. When shearing on a hot strip mill, the voltage applied to all motors may be reduced even though some motor fields are strengthened. The range in voltage reduction below normal is usually not more than 25 per cent.

Starting at no load is infrequently required and is usually accomplished by raising the voltage on all bus sections, at a slow rate, say in 30 sec. Individual motor starting panels are therefore not usually required. Stopping without load may be a "normal" stop by coasting to rest or an "emergency" stop in 5 to 8 sec.

Jogging is used when changing rolls or clearing cobbles.

During full speed rolling, load builds up on the bus as metal enters each succeeding stand, and likewise decreases in steps as the metal leaves each stand. In order to reduce the effect of transient speed changes, inherent to some degree in the motors, it is important

that bus voltage be held as constant as possible, especially so for tube mills and multi-strand rod mills which even require low impact speed drop motors to reduce transient tension changes or looping in the metal between stands.

Because of the practical impossibility of fully loading each stand motor, the amperes output of the d-c power source for a given bus section need not equal the total rated amperes of all the motors. The ratio of motor amperes to supply amperes depends not only on the type of mill, but also on the number of motors connected to a given bus section and may vary from 1.0 to 0.65.

The peak loads in the d-c power supply equipment depend on this diversity factor. Peak loads with metal in all stands of 150 to 200 per cent are not uncommon.

## SPECIAL FEATURES OF RECTIFIER EQUIPMENTS FOR CLASS I MILLS

Rectifiers meet the requirements of Class I mills very well. Figure 16 is an installation view of two 5000-kw rectifiers supplying a 54-in. hot strip mill.

When rectifiers provide the sole source of d-c power, they are always furnished with 100 per cent phase control for infrequent starting service. Stopping on a normal basis is accomplished simply by the motors coasting to rest. For emergency stopping, dynamic braking for each motor is provided.

When rectifiers are operated in parallel with existing motor-generator sets, 100 per cent phase control is usually not furnished as the generators are used for starting and stopping. Rectifiers can be made to parallel easily with existing motor-generator sets. Only simple small wire connections between meter shunts are required. A common arrangement in this case is to

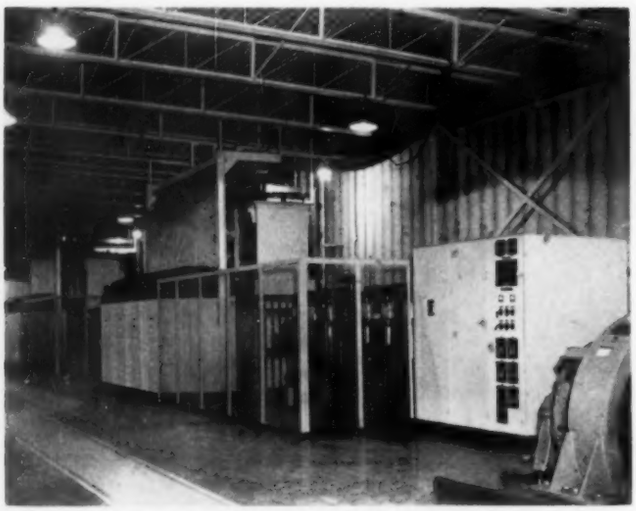


**Figure 16 — Two 5000-kw, 750-v, d-c rectifiers in motor room of 54-in. hot strip mill.**

assign the rectifier regulator the "master" task of holding bus voltage and the generator regulator the "slave" task of load division with the rectifier. The high momentary capacity and high speed of response of the rectifier permits holding bus voltage more constant with this arrangement.

Because of the high speed of response inherent with the rectifiers, and because of the sensitivity of the amplistat regulator, not only are load division problems easily solved but the bus voltage is regulated with a minimum of transient effect so important on tube and multistrand rod mills especially.

The total range by phase control under the command of the amplistat regulator on rectifiers supplied by our company for main mill drives is sufficient to hold rated bus voltage (plus any desired reduction in bus voltage below rated) with transformers designed to deliver sufficient anode voltage to guarantee rated d-c voltage with 95 per cent rated a-c sinusoidal voltage applied to the 100 per cent primary winding tap and the simultaneous maximum expected load peak (160 per cent for hot strip mills). It is important to note that 95 per cent of rated a-c voltage does not apply to all installations — some may involve more than 5 per cent voltage drop at the maximum load peak. It is also important to note that the reactance of the a-c system causes the wave

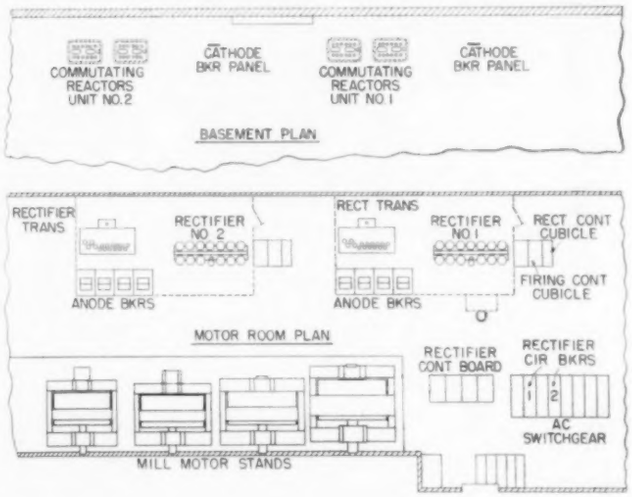



**Figure 17 — Plan of two 5000-kw, 750-v, d-c rectifiers which supply finishing stand motors of 54-in. hot strip mill.**

form to depart from a true sinusoid. Allowance for this effect should be made in compensating the transformer when it is designed.

The reduction in power factor caused by phase control on modern hot strip mill installations has been partly compensated for by the use of synchronous motors driving the roughing stands of continuous mills or driving the generators for the reversing roughers of semi-continuous mills.

Rectifier transformers are usually furnished with taps to permit the desired voltage reduction with minimum use of phase control. Tap-changing mechanisms have so far not been of the "load ratio" type but simply of the manually operated no-load type.

Figure 17 shows the motor room and basement floor plans of the two 5000-kw rectifier equipments of Figure 16 having all components located indoors. The accessibility to all components is a feature of this plan. The anode breakers draw out into the motor room operating aisle. The two commutating reactors are in the basement directly below the transformer — all three units being pyranol-filled, water-cooled. Special attention is called to the use of panel-mounted cathode breakers rather than drawout type cathode breakers. Because of the abnormally high short circuit currents

that large hot strip mill buses can deliver, disconnecting devices on these systems should be avoided.

## SHORT CIRCUIT CURRENTS FROM BUSES OF CLASS I MILLS SUPPLIED BY RECTIFIERS

It has always been realized that the short circuit current that can flow in and from the bus of a hot strip mill is tremendous and varies with time due to bus inductance, and the inductance of armature and series fields in motors and generators. It is only in the last 4 or 5 years, however, that calculations have been made on individual mills to determine the rate of rise and magnitude of these currents.

In the Chicago area, one 38-in. hot strip mill having d-c generators and d-c motors on roughing and finishing stands repaired the series windings of at least two generators and found the bus on the basement floor at least twice. This is the only known case of main bus failure. In other locations, some cases of damage to machine windings have been reported when machines have flashed over or when dead motors have accidentally been thrown on a live bus.

Because of the high concentration of power on a single bus usually found with Class I mills, the short circuit currents that can flow should always be investigated before determining the number of rectifiers or generators, bus arrangement and breaker selection. The series windings of a main drive d-c motor are normally designed to withstand the current that will flow when its terminals are short circuited, which is from 10 to 20 times rated current, but no more. Therefore, the systems of hot strip mills, which employ relatively large motors, and also merchant, rod and tube mills which generally use a larger number of smaller motors should be analyzed, especially from the standpoint of machine protection. The result of such a study is shown on Figure 18 for a hot strip mill using rectifiers.

When generators are used as the d-c power source, it is usually possible to properly protect motors by using high speed bus sectionalizing breakers, splitting the system quickly into three sections, because the rate of current rise is more like that of Curve B, Figure 18, for the motors. Fault currents to motors are so reduced that they usually can be interrupted soon enough by semi-high speed type breakers to protect the machines. This plan was recommended for the 38-in. hot strip mill mentioned previously and has been instituted there. This same sectionalizing system is also used on a rod mill being installed in Canada.

When rectifiers are used as the d-c power system source, this method of sectionalizing the system with high speed breakers cannot be used. The reason for this is that on arc-backs, a surge of current might possibly trip these sectionalizing breakers when there is no fault on the system. An arc-back might therefore split the bus and cobble the mill unnecessarily. A second reason becomes apparent from a glance at Curve A of Figure 18, which shows that the rate of rise of current from the rectifiers is much higher than with motors and generators. High speed breakers are therefore not fast enough to be effective either in splitting the bus or in tripping a rectifier off the bus during fault conditions.

Curve C of Figure 18 shows the current through the series fields of a flashed motor. Here the rate of rise is

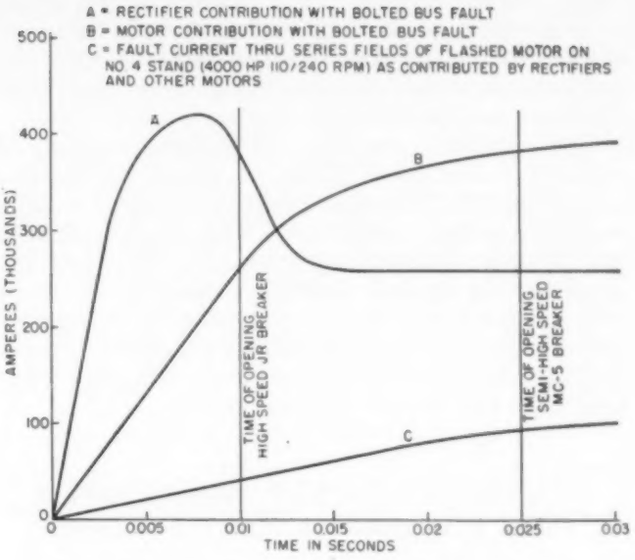
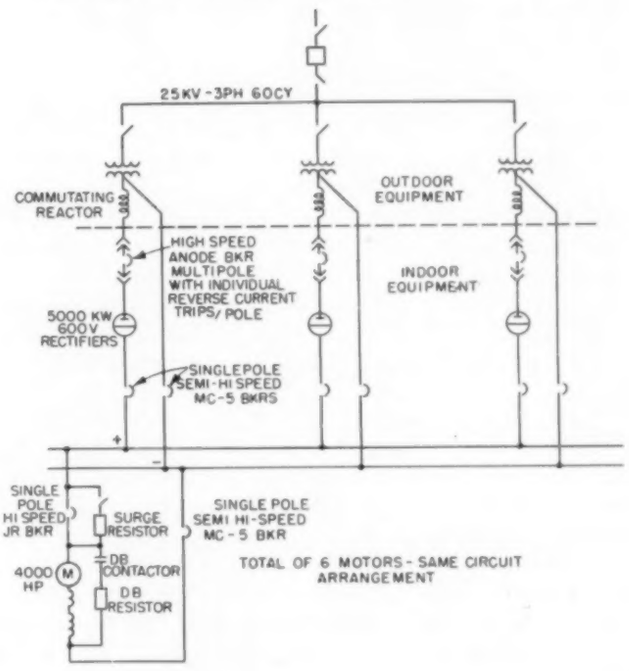



**Figure 18 — Curves show calculated fault currents in 600-v, d-c system of hot strip mill supplied by 15,000-kw of rectifiers feeding 23,000 hp of motors.**

such that high speed breakers can protect the motors by interrupting the current sooner than possible with semi-high speed type breakers.

The bus arrangement and breaker selection for the mill studied (results shown in Figure 18) is shown in Figure 19. High speed breakers are used for motor protection. These use double polarity tripping so as to help reduce motor contribution, as well as limit the current to a faulted motor. The surge resistor has been placed across the high speed breaker contacts to prevent

**Figure 19 — Circuit breaker arrangement of 600-v, d-c system of 66-in. hot strip mill for which fault current curves are shown in Figure 18. This illustrates use of high speed circuit breakers to reduce fault current contribution from and to motors.**



flash-overs and limit possible overvoltages from rapid opening of the inductive motor circuit. The use of this resistor requires its disconnection and the knife switch shown in Figure 19 is not the best device for this purpose, although fault currents through it are limited by the surge resistor.

This and similar studies point to the advisability of splitting the buses of Class I continuous mills into several sections. The higher cost of increased rectifier capacity required, because of less diversity is offset in part by the savings in bus bracing, breaker costs and by the better machine protection resulting. Rectifiers with amplistat regulators are well suited to tie separate bus sections to a common voltage standard, in much the same way as is now done with individual stand generators for tandem cold strip mills.

## APPLYING RECTIFIERS TO CLASS II — SINGLE STAND REVERSING MILLS WITHOUT REELS

Class II mills have the common requirement of fast reversal for every pass without a critical need for synchronizing another drive with it, such as a winding reel, and holding close values of tension in the metal. Blooming mills are the simplest and cleanest example of a Class II, single stand reversing mill.

The other reversing mills of this class — namely, slabbing, plate, hot strip mill roughers and even some structural mills — usually involve edging mills, either close center "attached" edgers in which the metal is rolled in the main reversing mill and the edger simultaneously, or "detached" edgers in which simultaneous rolling with the main mill is never done.

Rectifiers have been used in Europe for supplying the main drive of blooming mills. Only a single rectifier is employed with armature reversal of the main drive motor so that the rectifier operates as an inverter during the decelerating periods of the reversing cycle. The armature reversing switch for such a drive as built in Germany is shown in Figure 20.

The actual switching of the armature is done with zero current through the switch. Special excitation control is used to insure zero current. Current limit control is employed to limit accelerating and decelerating current peaks.

Neglecting the cost of development of the armature switching device, a rectifier so applied to a blooming mill would seem to offer lower equipment installation and maintenance costs, plus very rapid acceleration and deceleration, limited only by the commutating ability of the motor. To be balanced against this are the effects on the power system, both of rolling peaks (now softened by flywheel motor-generator sets) and the substantial amount of lagging kva imposed by the rectifier.

While it is not known that a switching device similar to that shown in Figure 20 has ever been developed by an American electrical manufacturer, it is possible that one could be. As a prediction, I venture to say that someone in the United States is going to apply a rectifier to a Class II reversing mill — the main question is when. Nevertheless, motor-generator sets will, no doubt, continue to be a popular choice for Class II mills for many years to come.

The smaller drive for an "attached" edger would appear to be best supplied with variable voltage from a generator having an excitation system designed for high rates of response or from another rectifier. Field weakening would be used only for the same range as the main mill motor, plus the speed range occasioned by changes in edging mill roll diameter. For a "detached" edger, the power supply would, of course, be the rectifier for the main drive unless it operates independently, in which case the edger becomes another Class II mill.

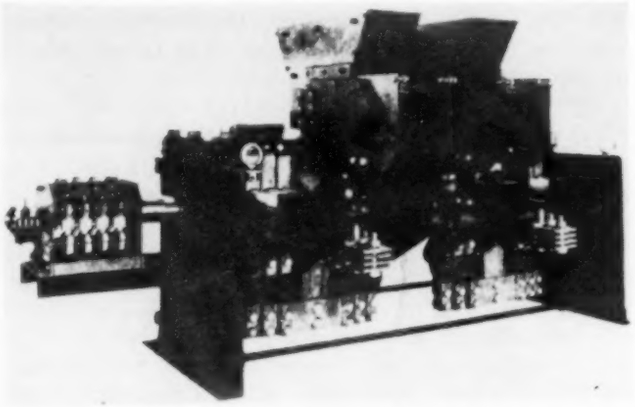


**Figure 20 — This reversing contactor for a blooming mill motor of about 7000-hp is used in conjunction with a mercury-arc rectifier built in Germany.**

## APPLYING RECTIFIERS TO CLASS III — STRIP MILLS WITH REELS, FREQUENTLY ACCELERATING, DECELERATING AND EVEN REVERSING WITH LOAD

Class III accelerating strip mills are characterized principally by the strict requirement of maintained and controlled values of tension between the stands and reels during rapid acceleration and deceleration and even under stalled conditions. Many mills of this class must also reverse without loss of strip tension.

These Class III mills therefore do not permit switching of a single rectifier, as do Class II mills. Since power is regenerated during deceleration, it is therefore necessary to use two rectifiers (one acting as an inverter). This means that the rectifier equipment will cost considerably more than the motor-generator set equipment.

If a prediction may again be ventured, it is extremely unlikely that rectifiers will ever be used instead of generators to supply the main roll drives of Class III mills.

## SUMMARY

Considerable progress has been made, especially since 1949, in the application of rectifiers to main roll drives. This progress has been accelerated by the economic advantages of rectifiers over motor-generator sets and the developments that have been made in rectifier equipments improving their reliability, and performance and simplifying their installation. So far, in economic studies, the inherently lagging power factors of rectifier equipments have been accepted without penalizing

them by the inclusion of power factor improving equipment.

Rectifiers have been applied only on Class I continuous mills, in the United States. These mills, with heavy power concentrations on single buses, sometimes reach the point where it is better to split the system into smaller separate systems to reduce fault current. Rectifiers for each separate system can easily be regulated against a voltage standard providing the equivalent of solid bus operation. Splitting the system adds some cost penalty to the rectifiers since reduction in diversity increases required rectifier capacity, part of which is recovered in bus and breaker cost savings.

For Class II reversing mills, rectifiers have been used in Europe and may in the future, for economic reasons, be used in the United States although generators will no doubt continue to be the popular choice for years to come.

Class III accelerating strip mills present the greatest handicaps to rectifiers, both economically and in performance requirements. It is doubtful if the future holds much promise for the application of rectifiers to Class III mills.

As more rectifiers are used in steel mills instead of motor-generator sets, the need for power factor improving equipment will become compelling. Economic comparisons of rectifiers, including power factor improving equipment with motor-generator sets, will tend to retard the rate of new applications and will tend to leave Class III mills to the motor-generator set.

# CURRENT AISE DISTRICT SECTION MEETING NOTICES

## BIRMINGHAM SECTION

Friday, December 12, 1952, 6:30 P.M.

**Christmas Dinner and Dance**

Thomas Jefferson Hotel, Birmingham, Ala.

▲

## BUFFALO SECTION

Friday, December 12, 1952

**Christmas Dinner and Dance**

Hotel Statler, Buffalo, N. Y.

▲

## CHICAGO SECTION

Saturday, December 6, 1952

**Christmas Dinner and Dance**

Hotel Congress, Chicago, Ill.

## CLEVELAND SECTION

Friday, December 5, 1952

**Christmas Dinner and Dance**

Allerton Hotel, Cleveland, Ohio

▲

## DETROIT SECTION

Friday, December 5, 1952

**Christmas Dinner and Dance**

Detroit Yacht Club, Belle Isle, Detroit, Mich.

▲

## PHILADELPHIA SECTION

Saturday, December 6, 1952 — Dinner 6:00 P.M., Meeting — 7:00 P.M.

**"Chesapeake Bay Bridge"** by E. L. Durkee, Engineer of Erection, Fabricated Steel Division, Bethlehem Steel Co., Bethlehem, Pa.

## PITTSBURGH SECTION

Friday, December 12, 1952 — 7:30 P.M.

**Christmas Dinner and Dance**

William Penn Hotel, Pittsburgh, Pa.

By LAURANCE F. VAN MATER, Chief Metallurgist, Simonds Saw and Steel Co., Lockport, N. Y.

# HEATING STEEL IN A SPECIALTY MILL

*. . . . an extremely wide range of heating equipment is needed for best operation in a specialty mill . . . .*

▲ THE heating of steel in a specialty mill differs only in detail from other steel heating practices. The same basic considerations of temperature control, control of scaling, control of decarburization, and the economics of the method as related to the overall economics of production, exist in all steel heating procedures.

There are no fixed rules or even established trends in equipment design for *all* operations. Type of equipment and procedures are influenced as much by tonnage involved as by the particular characteristics of the alloys. In fact, as many variations in practice probably exist among the speciality mills of the country as between production mills and speciality mills in general. Thus, methods of heating in any one plant are dependent upon its particular items of specialization, tonnage and general past history of development.

This discussion will cover the general heating procedures in a specialty mill of relatively small tonnage and rather widely diversified products, including such items as high and low expansion alloys, permanent magnet steels, corrosion and heat resistant alloys, valve steels, high carbon-high chromium and high speed steels, and special purpose tool steels. It is not within the scope of this paper to discuss the heating of the individual alloys. In a more general way, they will be grouped according to the type of heating involved. The heating itself will be considered in a generally chronological order through the various stages of hot working and including subsequent heat treatment.

## INGOT HEATING

Almost without exception, in the particular mill under consideration, all ingots are hammer cogged. The complete working range for the various grades include temperatures from as low as 1400 to approximately 2350 F. On any one shift, one to a half dozen different alloys may be forged. Thus, while preparatory holding in soaking pits has been considered at various times, the complexity of grades, variety of temperatures required, and in many cases the small volume of any one analysis involved, has indicated only limited use for such equipment. Accordingly, at the present time the two hammers used for cogging are serviced by six open-fired oil furnaces with end burners. These six units offer a reasonably good degree of flexibility which is all-important in all operations in a specialty mill of the type under discussion.

Ingots are charged cold, or hot as stripped from the moulds, depending upon the grade. At the time of charging, the furnaces are relatively cold after which they are brought gradually to temperature and so adjusted as to coincide with the working schedule of the hammer. As an ingot is removed for working, the remaining ingots are rolled toward the hot end of the furnace. In this manner, the ingots are constantly being turned with new surfaces exposed to the heat and at the same time, the temperature of the individual ingots is gradually increased with only the first few ingots nearest the burners actually at forging temperature. In actual practice two furnaces are frequently used at the same time with ingots being removed alternately for working. This is particularly true when more than one heating is required for the desired reduction.

The above-mentioned details of operation have purposely been included because of their relationship to the two important considerations, scaling and decarburization. All open-fired furnaces are basically oxidizing and decarburizing. These reactions are closely associated and complicated by each other, and in conjunction with the variables of operation and equipment, produce a set of conditions not yet fully understood. The same factors affect both reactions in varying degrees. These include the analysis of material being heated, working temperature, kind of fuel, type of burner, burner adjustment, furnace pressure, and time at temperature. Analysis and working temperature are approximately fixed factors for any one alloy. The kind of fuel, type of burner, and burner adjustment are relatively unimportant in their effect if the furnace pressure is negative, for free air and water vapor drawn into a furnace under negative pressure are of the strongest order in their oxidizing and decarburizing action. This then would seem to indicate positive furnace pressure to be highly desirable. Under positive furnace pressure, however, an increasing number of factors, as already pointed out, become effective and must be balanced so that the relative speed of the reactions of oxidation and decarburization are kept under proper control. In negative pressure furnaces, the *net* decarburization is also dependent upon the relative rates of the two reactions and while both rates may be higher, a proper balance can be maintained without excessive scale loss by control of the seventh and last-mentioned factor, time at temperature, which for proper control is kept at a minimum consistent with good working characteristics of the alloy involved. Thus, very satisfactory results can still be obtained by the old and tried method of minimizing decarburization by controlling the rate of scaling.

The broad range of temperatures employed in the

type of furnace described presents a definite problem for the installation of any permanent temperature indicating or control equipment. On the more common grades of steel requiring forging temperatures in the range of 1850-2200 F, the heater, who in many cases becomes remarkably accurate, is relied on to a large extent for control with only an occasional check by an observer with an optical pyrometer. For alloys in this range which possess critical working temperatures, as well as those with high or exceedingly low temperature requirements, a constant check is maintained with an optical pyrometer. While laborious, this method of temperature determination possesses good accuracy and does increase the flexibility of the equipment. In some cases where only a few ingots of a particular grade are involved, alloys possessing appreciably different working temperatures may be heated at the same time by planned placement in the furnace.

## BILLET HEATING

The heating of billets at the bar mills and sheet bar at the cogging mill is carried out in equipment of the same general type, and by the same general methods as those employed in the heating of ingots. The stock for these mills is, of course, of considerably less mass and, therefore, the time required for heating is materially reduced. In some cases, too, the temperature may vary appreciably from those employed on the same alloy in the ingot. This is particularly true of the higher alloy grades which do not scale freely. High nickel alloys with or without small percentages of other elements, in general have a broad plastic range and in finishing are worked at temperatures below the scaling point for the production of the best surface condition. High chrome-nickel alloys possess relatively high hot hardness and, therefore, must be worked at higher temperatures, up to 2200 F, depending upon the particular analysis. Even at the elevated temperatures employed, these alloys maintain a tight scale. Low alloy grades of eutectoid and hypereutectoid carbon content are for the most part free scaling in the average working range of 1900-2000 F. Again this scaling helps to control decarburization without detrimental effect to the surface of the finished bar. It should perhaps be pointed out here that the amount of mechanical reduction is also an important factor in the control of decarburization. This reduction of cross-sectional area in turn increases the surface of the stock being worked, and correspondingly decreases the thickness of any decarburized skin which may have been formed in the heating furnace.

## HEATING — SHEET MILLS

Heating at the sheet mills follows the same basic principals employed in the hot working operations already described but with certain modifications in equipment and procedure. These mills are each serviced by a three chambered furnace, each chamber being individually controlled and to all intents and purposes an individual furnace. Each chamber is fired from the back with flues so arranged both front and back as to produce a uniform temperature condition throughout the heating area. Here, permanently installed temperature recording and control equipment may be employed satisfactorily. Again, the three chamber arrangement produces a good degree of flexibility. The operating temperature of the individual chambers is dependent upon the type of material being rolled and the finish gauge. Free scaling steels such as straight carbon tool steel may be heated to 1800-1900 F in the first chamber, and then completely descaled with high pressure water before any reduction on the mill. If the finish gauge is such that reheatings are necessary, these are carried out in the second and third chambers at lower temperatures below the scale breaking point. Many of the alloy grades are completely descaled in the blank by pickling or sandblasting. The sheet mill heating is then maintained at a temperature below the scale breaking point, the actual temperature being dependent upon the individual characteristics of the alloy being worked.

## ANNEALING

The annealing of hot rolled stock both sheet and bar is accomplished by one of three general methods depending upon the analysis of the material and the specified requirements. With few exceptions, martensitic alloys requiring a "full" or "spherodized anneal" are packed in containers. In years past these containers were completely filled with charcoal after the steel was in place. It has been found, however, that a relatively small amount of charcoal in each container gives approximately the same protection as a solid pack. Accordingly, hot rolled sheet stock after pickling is stacked on boiler plate bottoms supported by heat resistant alloy frames. After a pile of sheets is completed, a trough of charcoal is placed along either side of the stack and a boiler plate cover put over the entire charge. The joint between the cover and bottom is sand sealed.

Bars, for the most part, are packed in pipes although some flats and large rounds of short lengths are handled in boxes in a similar manner to sheets. The pipes used for containers are centrifugally cast, approximately 14 ft long and 12 in. in diam. These are filled as completely as possible with bars after which charcoal is placed in either end. Caps are then wedged on and luted with fire clay after which the pipe is ready to be charged into the furnace.

The furnace equipment in this department consists of one car type and three pit furnaces electrically heated, each with a rating of 300-kw. Each furnace is divided into two zones of control, and immediately adjacent to each control thermocouple is a check couple. By means of a check indicator and a multi-point switch, any zone in any one of the four furnaces may be checked at any time. These furnaces produce excellent uniform heating. The maximum charge per furnace for sheet stock is approximately 10 tons and slightly less for bars. The annealing cycles are, of course, dependent upon the type of alloy and the weight of the charge.

Austenitic type alloys requiring annealing temperatures in the range of 1900 to 2200 F are handled in open fired furnaces with optical pyrometer control. Single rows of sheets or bars are charged at one time and after a proper soak at temperature, the stock is pulled out and rapidly cooled on floor plates. It is sometimes neces-

sary to water quench certain grades of heavy cross section. If the specifications, particularly on the chrome-nickel grades, call for a pickle after the anneal, it is important to keep the furnace condition as oxidizing as possible. Even at the high temperatures indicated, it is possible by improper control, to produce a scale which is very difficult to remove uniformly.

Many items of sheet and light plate call for a "floor anneal" or "semi-anneal." While these designations are not exacting in their requirements, they generally indicate a Rockwell "C" hardness between 20 and 30 to permit shearing and punching. The bulk of this work is done in a continuous roller hearth furnace. The furnace is open fired, utilizing city gas for fuel. Its effective length is approximately forty feet and it is divided into four zones each automatically controlled. The speed through the furnace is infinitely variable between the limits of approximately 3 minutes and 70 minutes door-to-door. The variable speed plus the four independent zones of control produce a highly flexible unit. It is practical to carry out various thermal treatments from normalizing at a maximum temperature of 1650 F, to an actual sperodized anneal of approximately 90 "B" Rockwell hardness on straight carbon sheet stock. Thin high speed sheet stock may also be annealed to a Rockwell "C" hardness in the low twenties in approximately a one-hour cycle. Although as stated before, this furnace is open fired and oxidizing, the various cycles are of such short duration that no perceptible decarburization has ever been noted.

### THERMAL TREATMENT — COLD ROLL DEPARTMENT

This discussion would not be complete without a few remarks concerning the thermal treatment in the cold rolling department. Here the chief products are straight carbon and low alloy strip stock of approximately eutectoid carbon content. Prevention of decarburization is of prime importance. Accordingly, all annealing is done in hooded, electrically heated bell furnaces. Straight dissociated ammonia is used for an atmosphere. While expensive per unit volume, it is constant in composition and requires very little technical supervision. In this particular department its use is felt warranted.

Dissociated ammonia is also employed in electrically heated continuous strip furnaces. It is of the utmost importance, however, that the furnace be absolutely tight and a positive pressure maintained throughout. Earlier, under the discussion of the hammer furnaces, it was indicated that as oxidizing conditions are reduced, decarburization may become more and more of a problem. It was also pointed out that water vapor and free air are highly decarburizing. The influx of free air in combination with the high hydrogen content of a dissociated ammonia atmosphere is fatal. As an actual example of the speed of reaction, a strip 0.032 in. thick in such an atmosphere for a total of four minutes, only two minutes of which was it actually at the furnace temperature of 1600 F, was decarburized to a depth of 0.002 in. practically carbon free ferrite on each face. On the other hand, under proper operating conditions, which are not at all difficult to maintain, dissociated ammonia gives excellent protection both from oxidation and decarburization and is highly satisfactory in every way.

Thus in this survey of the heating practices in a specialty mill, it is seen that extremes in equipment are utilized varying from manually operated, open-fired oil furnaces to automatically controlled electrically heated special atmosphere furnaces. In each case, the prime considerations are economic control of quality, flexibility of operation and effective aggregate tonnage.

## DISCUSSION


PRESENTED BY

**A. M. CAMERON, Superintendent Rolling Mills, Atlas Steels, Ltd., Welland, Ontario, Canada.**

**LAURANCE F. VAN MATER, Chief Metallurgist, Simonds Saw and Steel Co., Lockport, N. Y.**

**D. J. McGEARY, Heating Foreman, Steel Co. of Canada, Hamilton, Ontario, Canada.**

**B. M. MacKAY, Chief Draftsman, Atlas Steels, Ltd., Welland, Ontario, Canada.**


**A. M. Cameron:** Do you think that 100 per cent automatic furnace control is a guarantee of good heating practice?

**Laurance F. Van Mater:** Automatic control definitely is not a guarantee of good heating practice. Assuming proper placement of the temperature sensitive element in the heating chamber, there is still opportunity for false readings which may be affected by the size or shape of the load, speed of operation, burner adjustment, and other variables. I refer particularly to open-fired furnaces. I have seen cases in our own mill in which an experienced heater, who has depended upon manual control for years, has developed a tendency to check his indicator or control equipment and neglect actual furnace conditions when given automatic control. This practice can lead to trouble.

Automatic control is highly desirable, particularly in atmosphere furnaces or other closed types where it must be relied upon almost entirely. As in the case of any other tool, however, it must be used intelligently.

**D. J. McGeary:** In your charging of ingots in the furnace in the horizontal position, what precaution do you take to avoid the spreading of pipe in the ingot, assuming that a liquid condition is present at times in the interior of the ingot?

**Laurance F. Van Mater:** I think the basic answer to that question lies in the size of our ingots in comparison to production mill ingots. Our most common ingot size is 10 × 10 in., at approximately 1000 lb. These are allowed to stand from 45 minutes to an hour after being teemed before being stripped. We never have trouble from liquid centers in an ingot of this size. Not having had this problem, I cannot answer you as to precautions we might take except to increase waiting time to assure a solid ingot.

**Bruce M. MacKay:** Do you use charcoal when annealing Type 430 stainless?

**Laurance F. Van Mater:** No, we do not. On Type 430 we use the continuous furnace.

**Bruce M. MacKay:** Do you use dissociated ammonia?

**Laurance F. Van Mater:** No, the furnace is open fired with city gas. It produces ample softness and has the advantage of permitting a quick air cool from 1200 F.

# Multiple Generators for Processing Lines

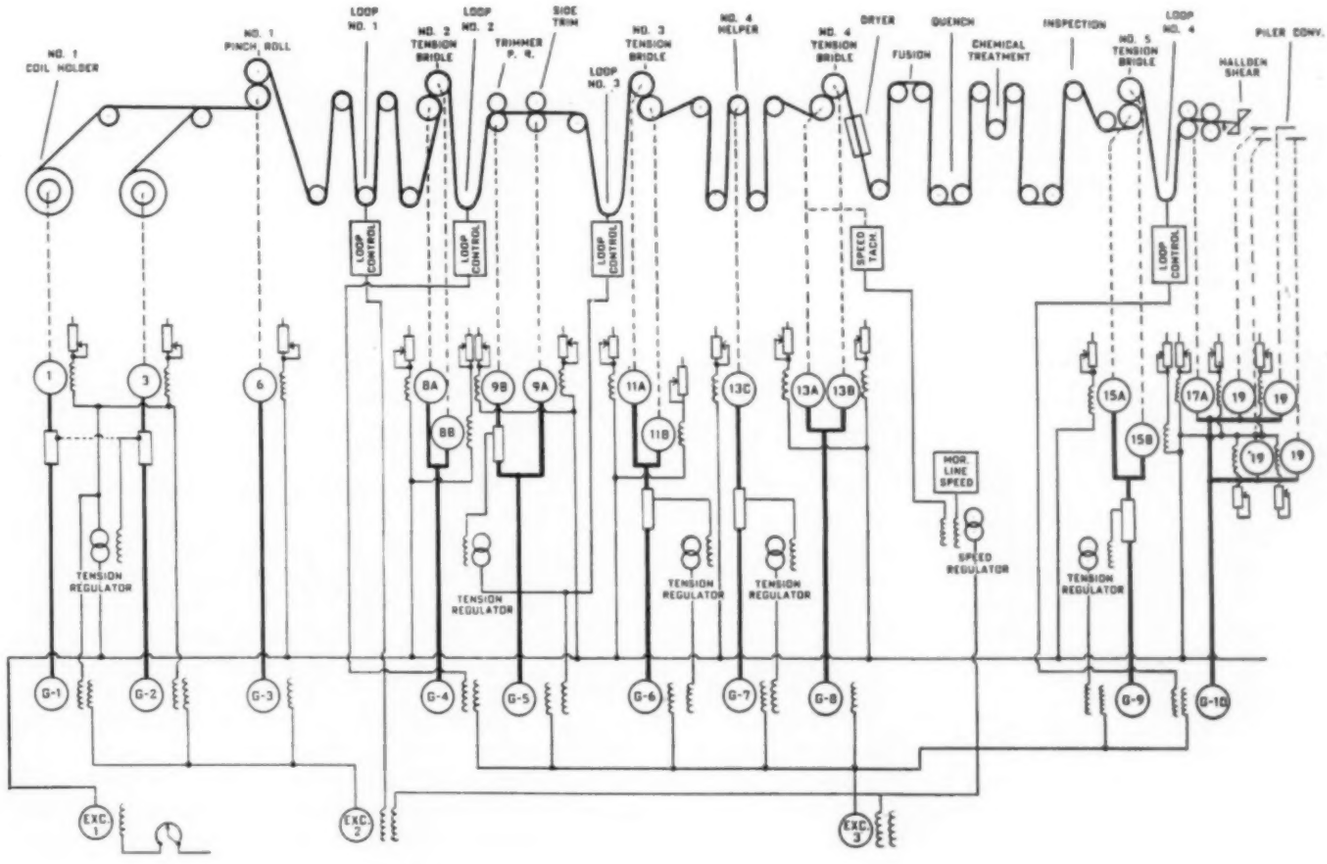
By E. E. VONADA
Application Engineer
The Reliance Electric and Engineering Co.
Cleveland, Ohio

*. . . . the simplest method of providing adjustable voltage power to some processing lines is to apply independent generators to each unit or small groups of units . . . .*

▲ IN discussions on high speed tandem mills, the trend has been to provide each mill stand and reel drive with its own generator. These high speed mill drives by sound engineering of drive motors and generators, plus adequate regulator control of auxiliary fields, have proved very successful in operation. In fact, they have proved so successful that it is no longer considered necessary in an adjustable voltage system to operate tandem mills from a common bus. Instead, the use of individual generators to supply the several motor drives comprising an overall mill installation has had several advantages.

For example, it has made possible a more economical power installation through the use of higher speed generators, has permitted an important reduction in

**Figure 1 — Schematic diagram of circuits in an electrolytic tinning line equipped with new multiple generator system.**



the bus and breaker capacities required and, has reduced the amount of electrical energy to be dissipated should a fault occur.

The greater flexibility possible in adjusting for the use of standard gear reduction units and for changes in diameter of rolls over which the strip travels are other important considerations.

These advantages of independent generators have also been recognized by the paper industry where over a somewhat longer period of time they have been used very successfully to supply power for individual section drives on paper machines.

It was in 1948, while analyzing the constant torque requirements for an electrolytic tinning line that it became apparent to our engineers that the simplest, most expeditious method for providing adjustable voltage power to the many driven units in the line would be to apply independent generators to each unit or small group of units adjacent to each other. This system was a distinct departure from the conventional arrangement previously employed whereby the entry, center and delivery sections were each supported by an independent generator, and boosters were added where necessary to assure proper synchronization of line speed.

Completion of comparative drive data showed that the new independent generator system was less expensive, not only because of the higher speed generators and fewer control devices involved, but also because actually one less commutator was required.

A schematic layout of a tinning line equipped with the new multiple generator system is shown in Figure 1. The two pay-off reels, which are used alternately, are driven by motors (No. 1 and No. 3) which are individually supplied by generators G1 and G2. A single current regulator is so connected that it can be used with either generating unit to control the motor field of the pay-off unit from which the strip is coming. The auxiliary fields on generators G1 and G2 are controlled by the current regulator to obtain correct armature terminal voltage for maintenance of the pre-set armature current. The variation in generator voltage from this field during coil build down is adjusted to compensate for variation in friction and windage losses of the motor, as the motor speed increases with decrease in coil diameter.

Through a minimum of control devices, the idle pay-off motor generator combination has been arranged so that it can be independently jogged to load and prepare a second coil for rapid welding to the trailing end of the coil being completed. Pinch roll No. 1, located at the entry end of the looping tower, is driven by a single motor (No. 6) served by generator G3. These items comprise the normal entry end equipment for a tinning line.

It should be noted that a single exciter (Exc. 2) is provided to supply main field excitation for the three generators. This exciter is equipped with dual fields; one energized from the main speed control regulator and the other commutated by limit switches on the looping tower to raise or lower the exciter voltage and thereby maintain the looping tower at the desired level.

The entry section of the line is necessarily divorced from the main center section, since it is necessary to overspeed the former to fill up the looping tower whose storage is rapidly depleted during the shutdown of the entry end for the welding of the leading and trailing ends of the new and old coils.

The strip is removed from the looping tower by No. 2 tension bridle, which has top and bottom rolls separately driven by motors (8A and 8B), both supplied by generator G4. Strip from this tension bridle enters loop No. 2. The latter is equipped with step loop control which acts upon an auxiliary field of generator G4 to modify generator voltage as required to maintain the loop at its pre-set depth.

From loop No. 2, the strip passes through a trimmer pinch roll and trimmer into loop No. 3. Trimmer pinch roll and trimmer are driven by separate motors (9A and 9B), which receive adjustable voltage power from generator G5. A second step loop control in loop No. 3 modifies an auxiliary field of generator G5 to maintain the loop depth at a pre-set value. Provision is also made for operation of these units with No. 3 loop eliminated. Under this condition, current regulated tension is maintained between trimmer pinch roll and No. 3 tension bridle. The current regulator also modifies the auxiliary field of generator G5 to maintain strip tension.

Tension bridle No. 3, located at the entry end of the plating section, is likewise arranged with top and bottom rolls driven by separate motors, (11A and 11B). These motors receive adjustable voltage power from generator G6. Regulated back tension is controlled by modification of an auxiliary field in this generator. A single motor-driven helper drive in the plating tank group is driven by motor 13C, served by generator G7, and is arranged for forward tension control by regulator modification of an auxiliary field of the generator.

Leaving the plating cell, the strip enters the No. 4 tension bridle which is the "lead" unit or pace-setter for the line. This is likewise a two roll bridle unit having top and bottom rolls driven by individual motors (13A and 13B) served by generator G8.

A tachometer generator driven by motor 13A furnishes a signal to a speed regulator whose output controls an exciter (Exc. 3) serving seven generators (G4 to G10) to a value necessary to maintain line speed to a pre-set value. Reference voltage to the speed regulator is provided from a motor-operated rheostat which permits speed adjustment from the conventional "Fast-Slow" pushbutton operation.

The strip then travels through the fusion, chemical treatment and inspection sections to No. 5 tension bridle which, like its predecessors, is a two roll unit having top and bottom rolls driven by separate motors (15A and 15B) which receive adjustable voltage power from a single generator G9. This unit is also tension regulated and in the same fashion, by modifying an auxiliary field on a generator to maintain a pre-set tension.

From this bridle, the strip enters loop No. 4 which is just ahead of the flying shear and classifier sections. These units, as indicated, are driven by individual motors (17A and 19), served by generator G10. Five photo-electric relays are provided in loop No. 4 to modify the auxiliary field of generator G10 and control shear and classifier speeds as required to maintain pre-set loop depth.

As the foregoing rather lengthy drive detail clearly indicates, adequate regulating units must be provided between major units, in modern relatively high speed

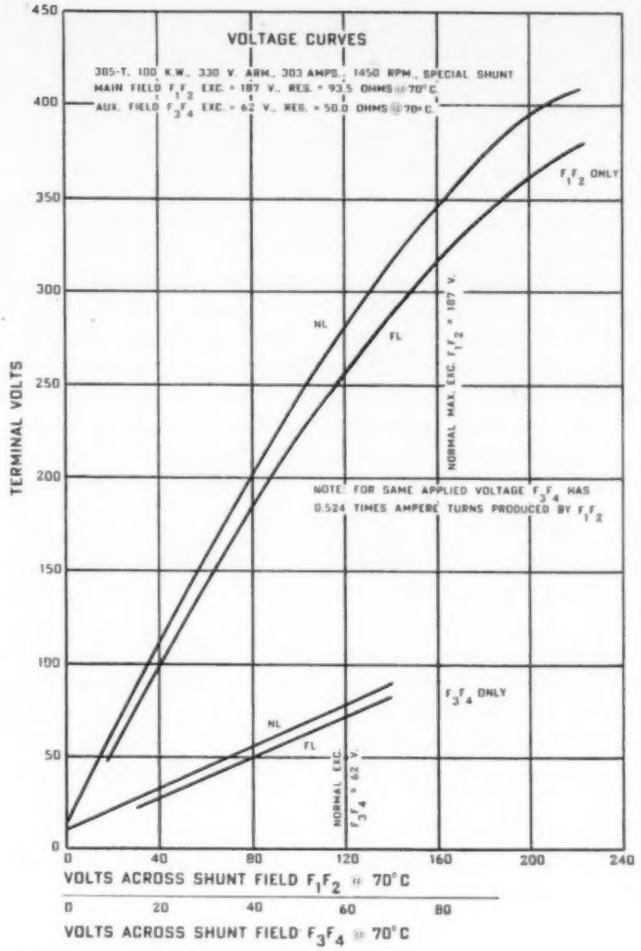

VOLTAGE CURVES
385-T, 100 K.W., 330 V. ARM., 303 AMPS., 1450 RPM., SPECIAL SHUNT
MAIN FIELD $F_1F_2$ EXC. = 187 V., RES. = 93.5 OHMS @ 70°C.
AUX. FIELD $F_3F_4$ EXC. = 62 V., RES. = 50.0 OHMS @ 70°C.
$F_1F_2$ ONLY
NL
FL
NORMAL MAX. EXC. $F_1F_2$ = 187 V.
NOTE: FOR SAME APPLIED VOLTAGE $F_3F_4$ HAS 0.524 TIMES AMPERE TURNS PRODUCED BY $F_1F_2$
$F_3F_4$ ONLY
NL
FL
NORMAL EXC. $F_3F_4$ = 62 V.
TERMINAL VOLTS
VOLTS ACROSS SHUNT FIELD $F_1F_2$ @ 70°C
VOLTS ACROSS SHUNT FIELD $F_3F_4$ @ 70°C

**Figure 2 — Typical voltage curves of one of the ten generators used in multiple generator system serving new electrolytic tinning line.**

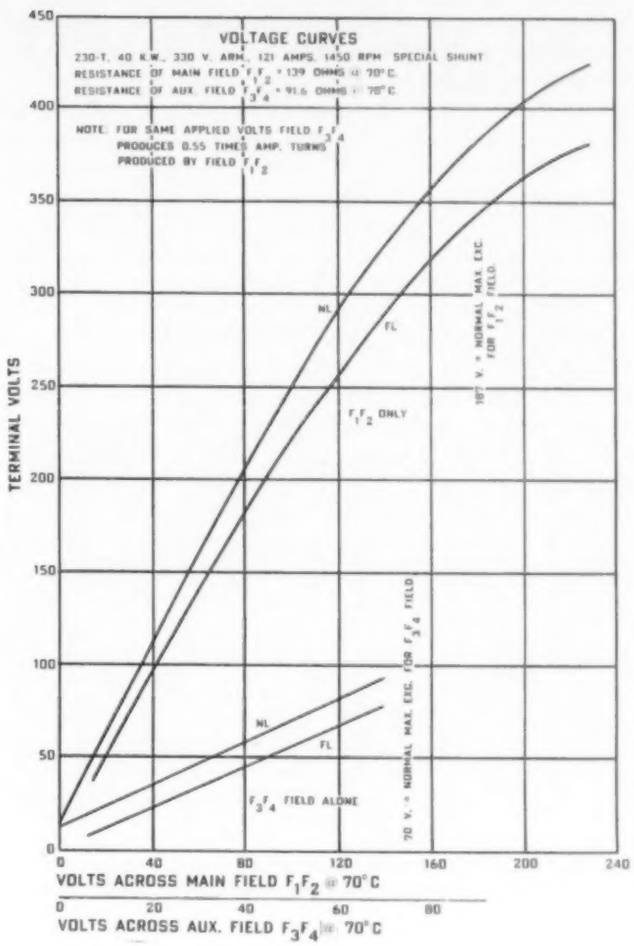

VOLTAGE CURVES
230-T, 40 K.W., 330 V. ARM., 121 AMPS., 1450 RPM. SPECIAL SHUNT
RESISTANCE OF MAIN FIELD $F_1F_2$ = 139 OHMS @ 70°C.
RESISTANCE OF AUX. FIELD $F_3F_4$ = 91.6 OHMS @ 70°C.
NOTE: FOR SAME APPLIED VOLTS FIELD $F_3F_4$ PRODUCES 0.55 TIMES AMP. TURNS PRODUCED BY FIELD $F_1F_2$
NL
FL
187 V. = NORMAL MAX. EXC. FOR $F_1F_2$ FIELD
$F_1F_2$ ONLY
NL
FL
70 V. = NORMAL MAX. EXC. FOR $F_3F_4$ FIELD
$F_3F_4$ FIELD ALONE
TERMINAL VOLTS
VOLTS ACROSS MAIN FIELD $F_1F_2$ @ 70°C
VOLTS ACROSS AUX. FIELD $F_3F_4$ @ 70°C

**Figure 3 — Curve of another generator shows behavior similar to that of Figure 2.**

(1200 fpm maximum) processing lines. With the multiple generator system provided for the drive described here, it will be observed that speed matching between units is obtained by generator voltage modification. Where a regulating means is provided, this type of control meets the requirements for constant tension because generator voltage, and consequently motor horsepower, is changed in direct relationship to lineal speed changes. On units controlled by loops, or regulators, modification of generator voltage provides the most rapidly responsive and stable means of speed control.

As previously mentioned, considerable rotating equipment engineering is required to insure that the drive will operate satisfactorily. Of greatest importance in this engineering work is the need for providing closely matched "generator main field-armature voltage" characteristics. This makes it possible to use common group exciters (Exc. 2 and Exc. 3) in such a way that only slight field series resistance modifications are necessary to obtain relatively close speed matching between units. In addition, it is necessary to provide adequate auxiliary field control range to assure compensation for variations in IR drops, and for small differences in generator characteristics.

Typical characteristics curves of two of the generators supplied for this job are shown in Figures 2 and 3. These curves are sufficiently detailed to permit ready comparison so further explanation is omitted.

A schematic arrangement of another tinning line recently put into operation is shown in Figure 4. Here again each main drive unit is served by an individual generator, except for the 26 small helper drive units in the plating section which are all supplied from a common generator. The main differences between this line and the line shown in Figure 1 are four in number: (1) the elimination of the trimmer and associated loops, (2) the substitution of small helper drive units for a single greater horsepower unit, (3) the addition of a delivery looping tower, and (4) the substitution of a tension bridle and rewind reel for the shear and classifier units.

Close examination of the drive arrangement shows that all units have regulating devices, arranged to act upon the auxiliary generator field for speed matching, and common excitation applied to generator main fields in each section.

In this latter installation the application of individual generators proved to be particularly advantageous, for it was possible to group them in such a way that they were fairly close to their unit drive motors, thereby keeping cable and conduit runs to a minimum.

Individual generators are equally applicable to small processing lines, such as slitting lines, shearing lines, and

side trim and recoil lines. On such lines the units are normally tied together either by loop control, or by regulators, which, as previously pointed out, can be operated very simply by generator voltage modification. It is important in such applications to drive a tachometer generator from the unit which is to be considered the pace-setter for the line, and to use this tachometer generator output either directly or through amplification to modify the several generator main field voltages in direct relation to the strip speed.

Multiple generator applications on processing lines, particularly those of more complex nature such as tinning lines, provide maximum flexibility for adding, replacing or eliminating units in the line. As an example of this, assume that the drag tension device of the tinning line shown in Figure 4, was found to be unnecessary after the drive was installed. In such an event, the generator could easily be removed from the motor generator set, control devices for generator and motor removed from the control panel and the combination of motor, generator and controls used elsewhere.

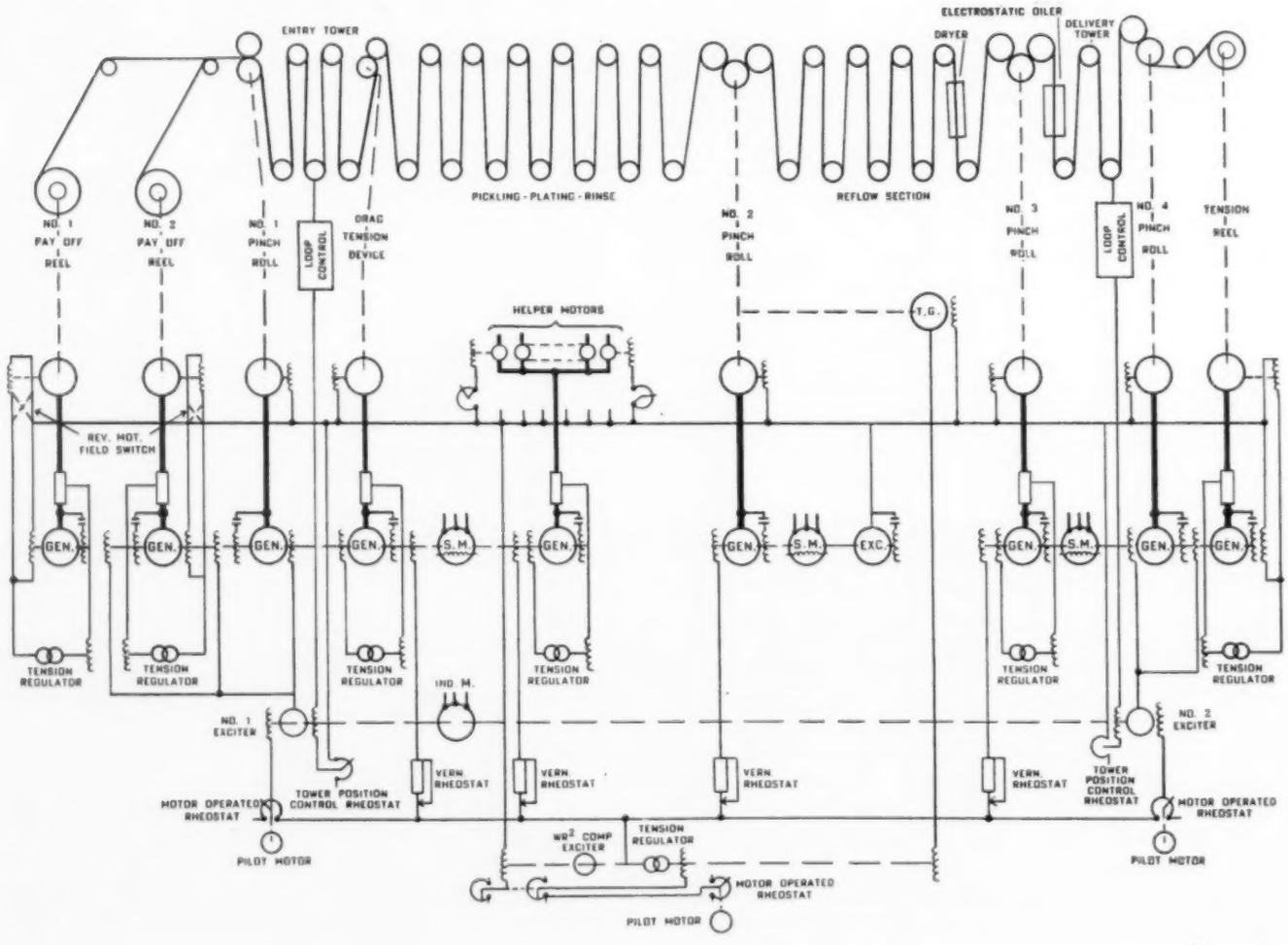
Should it be found necessary to increase horsepower on any of the units, a new motor and motor-generator set could be provided suitably designed with higher armature voltages, to make possible the use of the control devices originally supplied. And if creepage clearances proved to be inadequate on the control panel originally supplied, the main power units — contactors, overloads and knife switches — could easily be mounted on an auxiliary slate with proper spacing to provide adequate creepage distance for the higher voltage.

Should it be found necessary to add equipment to the line, such as a shear and a classifier, these additions could be made with a minimum of tie-in control by the addition of a motor-generator set, motors and control panel.

The multiple generator system is particularly useful on processing lines where the loading falls between constant torque and constant horsepower. Typical example of such a drive is to be found in the modern continuous galvanizing line where line speed varies inversely with the strip cross-sectional area. That is to say, on heavy gage strip, the line speed will be quite low compared to that obtainable with light gage, narrow width strip. The reason, of course, is that the strip pre-heating furnace in the line is rated in tons-per-hour, and the line speed must be maintained at such a value that the actual heating requirement does not exceed the furnace rating. Load data taken from existing lines indicates that because of the decrease in bending work around the rolls with a decrease in strip gage, the actual loading for such a drive falls between a constant torque and a constant horsepower requirement.

The foregoing condition permits the introduction of

**Figure 4 — Schematic diagram of circuits in an electrolytic tinning line equipped with individual generators for all unit drive motors plus single generator for 26 motors in plating section.**



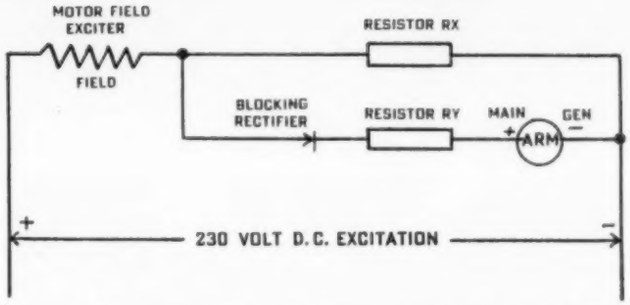



**Figure 5 — General circuit arrangement for "fade-in" system of power supply used with adjustable speed motors applied to new galvanizing line.**

adjustable speed motors with consequent relatively low kw rating of the supporting generators.

It also permits the use of a somewhat different method of speed control to keep in proper synchronization the driving motors in the several sections of a processing line.

This method as developed by our own engineers is termed a "fade-in" system. It is shown schematically in Figure 5, and involves an automatic weakening of the field of the driving motor as the voltage of the generator serving the motor builds up.

This method of control is particularly well adapted to applications requiring speed ranges as wide as 20:1,

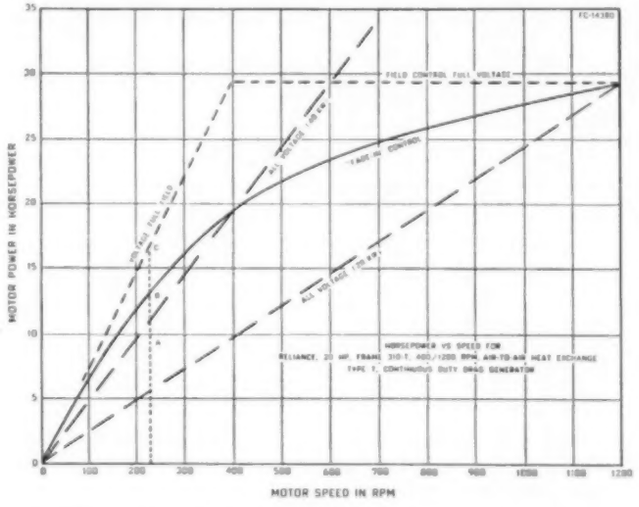



**Figure 6 — Curves of horsepower versus speed for "fade-in" system as applied to the four roll tension bridle in a galvanizing line.**

and relatively high values of horsepower at the lower speeds. Note that even with 20:1 speed range and 3:1 adjustable speed motors, generator voltage at minimum speed will be about 37 volts, compared with 13 volts on constant torque applications.

With this system the main fields of the variable voltage generators can all be commonly excited from a control exciter or directly from a motor-operated rheostat. In either case, the control is tailored to the system to provide equal speed change per step. An auxiliary field on each generator can be governed either from regulator or loop control to modify the speed of the unit, as required, to maintain any desired speed matching.

A tachometer generator can be driven by the pacesetter for the line to provide proper "line speed-generator voltage" change on generators supplying adjustable voltage power to drives where constant tension is imperative, such as pay-off reels, rewind reels or a furnace entry tension bridle.

Referring to Figure 5, the motor field is excited from the constant potential exciter provided for the line and the maximum speed limit is set by resistor RX. The field of the motor is designed for a reduced voltage, and

**Figure 7 — This group of ten generators supply adjustable voltage power for the motors driving equipment in the tinning line shown in Figure 1.**

resistor RY is selected to such a value as to maintain full field on the motor when the main generator armature voltage is at its minimum value. With this combination, an increase in main generator voltage has the effect of increasing the value of resistor RY, resulting in a decrease in motor field excitation.

As the generator voltage continues to increase, the point is eventually reached where no current flows in

**Figure 8 — Close-up of one of five tension bridle units for new electrolytic tinning line served by multiple generator system. Top and bottom rolls on bridle are individually driven by motors supplied with power from generator which serves them alone.**

**Figure 9 — Top and bottom rolls of tension bridles (No. 2 in foreground; No. 3 at left rear) are individually motor driven with each pair of motors served by its own generator.**

resistor RY and the motor field is effectively in series with only resistor RX across the exciter bus. This condition exists also at higher generator voltages because the blocking rectifier prevents current flow from the positive terminal of the main generator through resistor RY. By proper choice of motor field voltage, resistor RX and resistor RY, the "generator voltage-motor

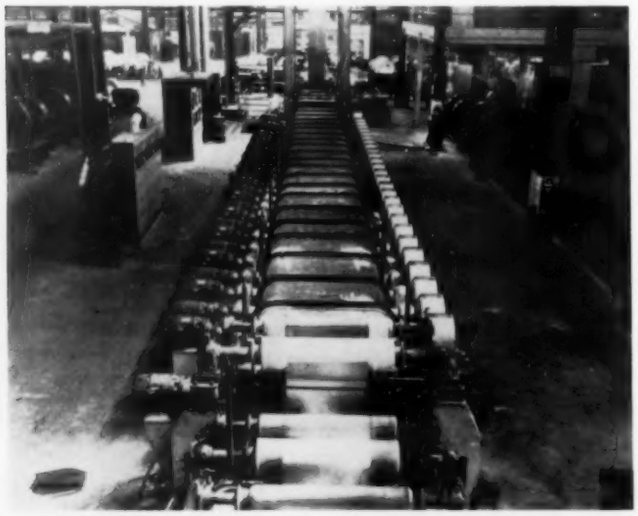


**Figure 10 — Delivery end of modern high-speed electrolytic tinning line. Line of conductor roll helper drive d-c gear motors assist in moving the strip through the plating tanks. This drive method reduces strip stress at the pulling bridle.**

speed" characteristics can be very closely matched between units.

The typical "horsepower-speed" relationship for a 20-hp drag-motor driving a four roll tension bridle and operated on this "fade-in" system of control is shown in Figure 6. All values of motor horsepower and torque are given in terms of full load.

The system also provides an ideal condition when jogging standard industrial type stabilized shunt motors in reverse, by reversing generator voltage. Under this condition, the polarity of the generator armature is reversed, which automatically increases the motor field strength above the normal continuous rating to provide additional field flux. This counteracts the opposing flux

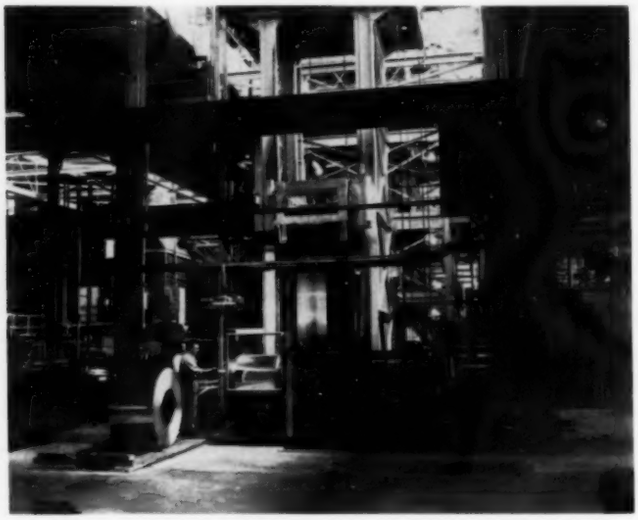
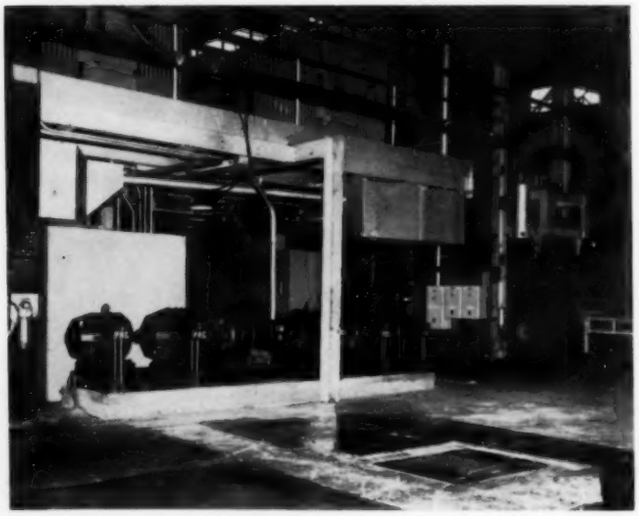


**Figure 11 — Wind-up reel at delivery end of same line shown in Figure 10. Observe closeness of control panel (right) to drive motor. Cable and conduit runs have been kept to a minimum by sectionalizing control and motor-generator sets.**

as set up by the series field with current flow opposite to the normal cumulative direction.

This "fade-in" system has been very successfully used on drawbench and scalper applications where carriage or bed return speeds normally exceed the maximum draw or cutting speeds by 3 or 4 to 1. Current limit regulator control of generator voltage is normally applied, and simultaneous weakening of motor field with generator voltage increase on the return cycle simplifies regulator application. This system also provides maximum average torque for acceleration and deceleration.

**Figure 12 — Entry end of same line as shown in Figure 10. Convenient and economical arrangement of motor generator set and control has been provided.**



# DISCUSSION


**PRESENTED BY**

**T. S. NOVAK, Assistant Electrical Engineer, Bethlehem Steel Co., Sparrows Point, Md.**

**ARTHUR L. SCHROEDER, Assistant Chief Engineer, Inland Steel Co., East Chicago, Ind.**

**ERIC PELL, Engineering Supervisor, Cutler-Hammer, Inc., Milwaukee, Wis.**

**EDWARD WINTERHALTER, Edward Winterhalter Co., Coshocton, Ohio.**

**D. C. McCRADY, Electrical Engineer, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada.**

**J. S. APPERSON, III, Application Engineer, General Electric Co., Schenectady, N. Y.**

**F. C. FENNELL, Steel Mill Engineer, Westinghouse Electric Corp., E. Pittsburgh, Pa.**

**E. E. VONADA, Application Engineer, Reliance Electric and Engineering Co., Cleveland, Ohio.**


**T. S. Novak:** Since I am more familiar with the second tinning line mentioned by Mr. Vonada, my comments will be limited to that installation. This line is geared for 2000 fpm on the entry and delivery ends and for 1500 fpm on the center section. The motor sizes, to give these speeds, were established by calculations from tests performed on an existing 900-fpm tinning line. Electrical personnel familiar with the type of line described are fully aware of the troubles experienced with torque requirements for the center section of these lines. Sensing the possibility of inadequate or additional center section drives, it was decided to use individual generators so that the flexibilities provided by this system could be fully utilized.

In the planning of the line it was decided to provide 3-hp helper motors for each of the 26 plating rolls. These motors are regulated as a unit to a current value sufficient to overcome the roll friction that is produced by the bearings and the collector heads, and to overcome the drag produced by the pump action and flexing of the strip. Helper motors on each plating roll are invaluable to the operating people in case of a strip tear off. By conveniently located individual motor cutout switches any helper motor can be made inoperative so that by proper selection of motors, the parted ends of the strip can be jogged together. The parted ends can then be welded together by a portable welder.

Not exactly what one might call an individual generator drive was provided for each of the 26 plating generators in an intermediate exciter. These intermediate exciters are excited by a common master exciter through small individual vernier rheostats. With this arrangement, the voltage of the plating generators may be adjusted for the individual generator or for the entire group. The use of the intermediate exciters was to provide our operating people with a 5 to 15-volt plating generator voltage variation, and by use of small adjusting rheostats, a more practical size of operating panel was obtained.

After the line went into operation, it was found that for better operation, a larger motor and generator should be added in the center section. An available 600-volt motor and generator were installed in place of the original 250-volt drives. The saturation curve of the 600-volt generator did not match those of the other generators. The other generators of the line are provided with auxiliary fields that permit armature voltage modification through the use of current regulators so that ample correction was supplied by these fields to operate the line in synchronism. It was possible to use the control devices originally furnished because of the higher armature voltage of the new drives.

**Arthur Schroeder:** A few years ago, we were talking about IR drop compensation, especially on rolling mills, and this thinking has been extended to the modern complex high speed processing lines. Of course, this business of individual generators is one of the methods of doing this. To compromise will often lead to trouble. I have in mind a trimming and shearing line installed in our plant a few years ago which was arranged for individual generators except for the shear and classifier which were on a common generator. Normally that sounds like a pretty good arrangement because the classifier should change speeds as the shear does. However, the classifier in this case was driven by 5 and 3-hp motors while the shear was driven by a 75-hp motor; the result was the shear would start faster and stop slower than the classifier. This caused cobbles in the classifier and we had to do something about it such as putting a booster or another generator in the line. A separate generator in the original installation would have cost no more than a booster, and would have cost less than the corrective steps taken. I believe before we can say that the individual generator is the answer for all processing lines, we must study each line completely before a decision is made.

**Eric Pell:** To the many advantages of the multiple generator system enumerated by Mr. Vonada, I may add a distinct simplification in the control by the elimination of separate and sometimes heavy power loops required with individual jogging of each drive of a common bus system. One could probably cite many other virtues of the multiple generator system without inviting arguments but instead I should like to briefly touch upon a few details in connection with the tinning line covered by Mr. Vonada's Figure 4, with which I am somewhat familiar.

As has been pointed out, the height or position of a looper may be regulated automatically by means of limit switches mounted at strategic locations along the tower, or also manually, if desired, by a looper position adjusting rheostat on the operator's panel. Manual regulation by this rheostat to any height, or automatic regulation by the limit switches to either a low or a high looper position is selectable by a 3-position master switch of the operator's panel.

As has also been pointed out, automatic regulation of a looper makes use of the respective section exciter, which is provided with two field windings. One of these is energized by the line speed regulating exciter in proportion to line speed, while the other termed the auxiliary field, can be made to either boost or buck the main winding, to raise or lower the section voltage and speed as required. This auxiliary field winding, therefore, is supplied from the constant voltage control source through a bridge circuit, one leg of which includes the

previously mentioned potentiometer rheostat for manual regulation of the looper height, and the other leg a potentiometer resistor with taps selectively connectable with the bridge by means of relays operated by the tower limit switches. The bridge, including the auxiliary field, may thus be skewed or unbalanced in either direction from either end, for either manual or automatic regulation of the voltage and speed of a section, and thus the looper height. For example, the operation of the 3-position selector switch of the entry end to its high position will unbalance the bridge a fixed amount to fill the tower at a maximum rate until the operation of a slowdown limit switch. This is shortly followed by a second limit switch, which will balance the bridge and reduce the section speed to that of the line. By a slight negative unbalance of the bridge, or some underexcitation of the main field, the looper is given a slight downward drift to permit regulation around the position of the second limit switch.

A return of the tower position selector switch to its low position will unbalance the bridge in the opposite direction to lower the looper at a fixed rate until the operation of the top limit switch of the low position restores the balance to the bridge for regulation of the looper height around this position.

Due to the fixed unbalance by each limit switch, a tower is filled, or emptied, at a fixed high rate, and smooth regulation achieved around the position of the second limit switch.

Another feature of some interest is the method of selection of the plating thickness, which, for a given number of plating generators in operation is inversely proportional to the line speed. In one unit, we find the reference signal field of the line speed regulating exciter supplied from the constant voltage control bus through two tandem connected potentiometer type rheostats. One of these is driven by the main motor operated rheostat which also controls the application of the plating generators through a series of relays progressively operated with the sweep of this rheostat. The other rheostat which is mounted on the operator's benchboard for manual operation, serves to modify the effect of the first rheostat on the reference signal and thus the line speed. The number of plating generators in operation thus will depend upon the position of the motor operated rheostat alone, while the line speed depends upon this as well as that of the manually operate plating thickness rheostat. By means of a special design and taper of these rheostats, so as to provide a constant equivalent resistance of the network of rheostats as viewed from the load side, the relation between line speed and position of either rheostat can be made linear regardless of the setting of the plating thickness rheostat. Specifically, the customary potentiometer rheostat collector track has been replaced by one of tapered resistance. It is the taper of this complementary section, or series resistance, of each rheostat which provides a constant value of the combined resistance of the network as viewed from the output end of the rheostats, for any position of either rheostat. We have found this type of design a very convenient means of properly superimposing several independent signals upon a common control field.

The sixteen plating generators are progressively applied with increase in line speed by the motor operated rheostat. For any position of this rheostat, that is, for any number of plating generators in operation, the line speed and plating thickness may be adjusted by the plating thickness rheostat over a 4:1 range, as shown.

I should also mention that the electrical connections between the plating generator control panel and the application sequence track of the motor operated rheostat includes a selector switch board of the plating operator's panel whereby any or all of the sixteen generators may be applied at any of the sixteen points of the sequence, thus permitting a shift or interchange of the plating generators for better utilization of the electrodes. This also makes it possible, if desired, to deviate to any degree from the linear relationship between line speed and number of plating generators in operation, so as to compensate for the effect of agitation of the solution and possibly other variables.

**Edward Winterhalter:** In looking at the elementary diagram of the tandem drive scheme which Mr. Vonada has presented, the first impression is that of complication which is never desirable if avoidable. Simplification, rather than complication, is naturally sought because a complicated control scheme is rarely a good one. Regardless of first impressions, the multiple generator variable voltage system described, has made a practicable contribution to simplification of control for extensive, high powered mill and processing line tandem drives.

The initial step toward this objective is usually that of dividing the overall variable voltage system into closely related component sections that require a minimum of broad range voltage adjustment between motors of each section, or reduction of power concentration to within limits of moderately rated control. These sections may, as has been indicated, include one or several main drive motors, and are equipped with individual generators.

After individual section generators have been applied to each, the problem becomes that of tying them together again into a system that is not only relatively simple, but flexible and stable over a wide range of automatic or manual adjustment. There is one point in this connection which cannot be over emphasized; it being that the usefulness of the multiple generator system in satisfying these overall "tie" requirements is dependent upon the developed qualifications of modern excitation and regulation systems. Summed up, it is the combination of excitation-regulation tie, and individual section generators that makes the multiple generator system attractive.

Another point deserving of more than passing notice is Mr. Vonada's mention of individual roll drives. Overall control requirements are somewhat greater and more exacting than those for the multiple roll drive, but to those who have benefited from use of individual roll drives, it is unnecessary to mention that they have many advantages including those of reduced roll maintenance, equipment vibration, and marking of strip product.

**D. C. McCrady:** With the modern emphasis on high speed production, and greater strip speeds on processing lines, far greater thought must be given to the choice of rotating equipment, its characteristics, and the arrangement of drives than was used heretofore. We all know what the trends have been during the past

fifteen years in connection with high speed tandem cold rolling mills along the same lines, to the extent that nowadays the principal concern confronting the designer of the co-ordinated mill drive is the choice of rotating equipment and the circuits which must be used in order to take care of problems involving speed coincidence, differences in drive inertias, and many special features required by our production friends. In other words, the main drive circuits and regulating systems are worked out first, to suit the particular application requirements, the control equipment then being designed to suit these overall requirements. On processing lines particularly, at this time, this represents quite a departure from the methods used as recently as several years ago, when, with lower speed lines, the control equipment was considered as a package unit which could be applied to any line regardless of its general makeup. For instance, a tension control was a package unit which was used regardless of line speed or other considerations, loop controls were also considered as a package device which could be added to any line regardless of its general makeup. Now, with higher speeds, these features have to be designed almost tailor-made to suit the particular requirements, particularly in view of the fact that inertia problems increase almost as the fourth power of the speeds involved.

One question which I wished to ask Mr. Vonada was whether or not some attention has been given to the use of a rotating regulator on the entering section of these processing lines, rather than using timed acceleration or motor operated rheostats. It would appear that, again with the higher speeds involved, that we could well do with a regulator to take care of the entry end acceleration and retardation problems to give better control over the entry generator voltage.

The "fade-in" control mentioned is most certainly an ingenious arrangement. I wondered whether this could be carried somewhat further, by having the line arranged whereby all motors would be brought up to full voltage at full field strength first, and then all motor fields weakened proportionately to reach top speed. In other words, the line speed control would still operate on generator voltage as far as regulation is concerned, but during the latter part of the acceleration cycle, actual acceleration would take place by means of motor field weakening. In this way it would seem that better use could be made of the available motor torques, particularly on lines where heavy material is handled at low speeds and lighter material at high speeds. The use of the "fade-in" control of course sacrifices to some extent the available motor torque at the intermediate speeds. Actually, of course, the method which I am suggesting is not new, as it has been used for years on single stand reversing cold mills, in order to provide heavy mill motor torque at low speed for the preliminary passes, and high speeds with lighter torques for the final passes.

**J. S. Apperson, III:** The advantages of the use of individual generators compared to one larger group generator for processing lines are not as clear cut as the same comparison on high-speed tandem cold strip mills. On processing line applications, the use of smaller generators does not necessarily mean that these generators may be operated at higher speeds. The general practice in the industry is to operate the generators of processing line sizes at 1200 or 1800 rpm, and it is doubted that the industry would look with favor on a suggestion of operating smaller generators at any speed higher than this.

The use of individual generators on tandem cold strip mills has made possible a reduction in breaker sizes and interrupting capacities, but there is not the same advantage to be gained in using smaller generators on processing line applications. The contactors may be of a smaller ampere capacity, but the NEMA standard ratings of 100, 150, 300 and 600 amperes, must still be adhered to.

The final answer as to whether a group generator or individual generators will be used for a group of motors depends upon the operating results and flexibility desired, compared to the cost of providing these desired results.

Some problems will be adequately solved, all things considered, with one generator feeding a group of motors, whereas, in another case, the use of individual generators is definitely advantageous.

For example, the processing line diagram in Figure 4 of the paper shows a common generator feeding the flying shear and the classifier belt motors on a tinning line. Here is a case expecially on high speed lines where the use of the two generators can provide real operating advantages. The flying shear is a relatively high inertia drive, whereas the classifier belts each have a relatively low inertia. When a common generator is used for this application, the difference in inertia will mean that the classifier belts will change speed much more rapidly than the shear during acceleration and deceleration. This lack of synchronization during speed changes will result in a change of the spacing on the sheets and may result in cobbles on the classifier. The belt motors also, in general, have a much higher IR drop than does the shear motor so that even during steady state conditions there will be a difference in the spacing of the sheets on the classifier belt, depending on whether the line is operating at a low speed or a high speed. By using two generators, a speed synchronizing regulating system can be used. A tachometer coupled to the first belt conveyor motor can be matched to a tachometer driven from the shear leveling rolls so that under steady state and transient conditions, the speed of the classifier belt is synchronized with the speed of the strip entering the shear.

The "fade-in" circuits suggested have some very attractive features and has been utilized in many instances in the past. However, there are several aspects of this scheme that should be considered.

Referring to Figure 6, first, it should be noted that by proper selection of motor field resistance and the resistance of resistors RX and RY the shape of the curve marked "fade-in" control can be made to lie anywhere between the lower "all voltage at 20-kw" curve and the upper curve marked "voltage full field and field control full voltage" curve. Where several drives are involved, it will be necessary that adjustments be made in the circuit values of each motor field circuit to have the curves for each of the motors matched.

Since the curves shown on Figure 6 are based upon the rated load of the motor, the vertical axis can be used to approximate applied generator voltage. With

this in mind, notice that at low speed a given change in motor speed or strip speed results from an appreciable change in applied voltage. At the high speed end of the curve, however, the same change in motor speed or strip speed is produced by only a very small change in applied voltage. This means that the accuracy and sensitivity of the regulating system used to control this voltage varies considerably over the range in output speed, and this condition will at least tend to introduce stability problems in the regulating system.

The top curve in Figure 6 represents the rated capacity of a 28-hp, 400/1200-rpm motor. The curve marked "fade-in control" represents the horsepower this motor will deliver when operating under the "fade-in" control scheme. At 400 rpm, this motor will deliver only approximately 19 hp rather than its rating of 28 hp. The area between these two curves represents the amount of motor horsepower, that is unavailable due to motor field weakening. In this case the torque available at 400 rpm is only approximately 67 per cent of the motor's rated base speed torque.

On certain processing lines, such as a continuous galvanizing line, where the load is, as Mr. Vonada describes in this paper, a combination of constant horsepower and constant torque, the "fade-in" control scheme is certainly applicable. However, let us consider a case where knowledge of the application indicates that a motor capable of delivering horsepower as shown in Figure 6 is perfectly adequate for the load imposed in handling the strip for which the line and furnace are designed. It has been our experience that the capacity rating of a line does not mean much for long. The operating personnel at the mill very quickly find ways and means of getting more than capacity output from the equipment and thereby improving their production costs. The continuous galvanizing line at Gary, for example, has a rated capacity of 10 tons per hour but is frequently producing as much as 12.5 tons per hour. This extra tonnage means that heavier strip must be handled at higher speeds than originally contemplated.

The limitations of the "fade-in" circuit must be completely realized before this scheme is applied even to lines such as a galvanizing line, and all concerned must be aware that the motors may not deliver their base speed rating.

**F. C. Fennell:** Mr. Vonada mentioned the advantages of the multiple generator system as they applied to high speed tandem mills. In the usual case these advantages do not appear so pronounced for processing lines due to their relatively low power requirements. It appears that the principal advantage of this system for processing lines is in the reduced equipment cost available in some cases.

Generally speaking, several conditions must occur in order for the cost of the multiple generator system to be favorable. *First*, the speed range of the line must be wide enough that booster generators would be required if a common bus system were used. The boosters tend to offset the cost of the individual generators. *Second*, the line arrangement must be such that each major drive unit requires a regulator for speed, tension, or loop control even with the common bus system. Mr. Vonada has mentioned the necessity of these regulators with the multiple generator arrangement. *Third*, the large capacity drives of the line must be used for bending the strip or overcoming friction, and not merely in circulating current to maintain strip tension.

An example will illustrate the reason for the third condition. Let us assume we are dealing with the delivery end of a high speed cleaning line which has a 200-hp motor on the winding reel and a 150-hp motor on the tension bridle. With the multiple generator system a 200-kw generator would be required for the reel and a 150-kw generator for the bridle — a total of 350 kw in generator capacity. With the common bus system, however, the generator needs only to have sufficient continuous capacity to supply the unrecovered losses of these motors — in this case about 75 kw. The necessary boosters increase the requirements a small amount, but the total capacity is far less than the 350 kw required with the multiple generator system, and costs are in proportion.

In the early part of 1947, our company built the electrical equipment for a multiple generator processing line consisting of five generators supplying power for the individual drives of a continuous coating line. This line was placed in operation in 1948, and was followed in the same year by another larger line which had eight generators. Both of these installations had what Mr. Vonada calls the "new system" of control. Based on the experience gained on these and later installations, it is our opinion that the multiple generator system will be selected, and the advantages of that type of control will be realized where the cost of the installation can be made attractive.

**E. E. Vonada:** My answer to Mr. McCrady's question concerning use of a rotating regulator on the entering section of the processing lines for current limit speed change control, is that the application has certainly been considered for numerous lines. The limiting factor to the application has been pay-off motor horsepower. The necessary tension horsepower is usually far less than the horsepower required to accelerate and decelerate the heavy large diameter coils, presently used, with current limit control. The added cost of larger pay-off motors and associated equipment is the only factor that, to my knowledge, has prevented the utilization of the faster, better regulating current limit system.

Mr. McCrady's suggestion to extend the "fade-in" control system by first covering the generator voltage range with concurrent group field weakening, retaining the voltage regulation feature, is certainly a good one. As indicated this system has been applied successfully on drives where the torque-inertia ratios are pretty well balanced. On drives where an appreciable ratio unbalance exists, there is a tendency toward instability on the heavy inertia units, when operating near the maximum field weakened speeds. Instability is eliminated with the "fade-in" control, for the simultaneous modification of motor field strength with generator voltage, materially reduces the voltage change necessary for correction, thus preventing the over correction that results in hunting. Motor field time constants are automatically reduced by the necessary low voltage motor fields required to maintain higher torque and permit speed relationship adjustments.

By W. H. DURRELL
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# DEVELOPMENT OF QUEBEC-LABRADOR IRON ORE

***. . . . the new Canadian ore field will start shipments of ore in the summer of 1954 . . . . plans are based on an initial annual production rate of 10,000,000 tons, rising to 20,000,000 tons . . . .***

▲ THE Quebec-Labrador iron ore deposits, as we know them today, have been developed from an original discovery in Labrador in 1929. Seven years later, a 20,000-sq mile concession was obtained by Montreal mining interests; and in 1939, a license in the Province of Quebec was granted to allow exploration of 3900 sq miles adjacent to the Labrador concession. It was in 1942, however, that the development really commenced with the association of Hollinger Consolidated Gold Mines Limited, well known in Canada, and The M. A. Hanna Co., of Cleveland, Ohio.

For the next seven years, work consisted of exploration, geological surveys, mapping and extensive drilling, with the last named activity commencing only in 1947. In 1949, Iron Ore Co. of Canada was formed for the purpose of further financing the development; and, in this new organization, five American steel companies: Republic Steel Corp., National Steel Corp., Armco Steel Corp., Wheeling Steel Corp., and The Youngstown Sheet and Tube Co., joined with Hollinger-Hanna and the concession companies with the definite view of preparing for commercial production.

Today, Iron Ore Co. of Canada has the right to lease a large part of the iron ore deposits in both Quebec and Labrador, with the original concession companies retaining appropriate reserves for the Canadian steel industry and for export overseas.

The Quebec-Labrador iron ore deposits lie 360 miles north of Seven Islands, a port on the North Shore of the St. Lawrence, some 500 miles below Montreal. The concession area in which we are working is almost the equivalent of a strip a mile wide around the earth at the Equator. Some of the area is favorable to the deposition of non-ferrous metals, but the greater part of it is good prospecting ground for iron ore.

The best idea of the extent of our iron ore area may be attained through some comparison with the famous Mesabi range. On that range, the area of favorable rock is 110 miles long and from one to five miles wide, with a productive zone of about 70 miles in length. On our concession, situated in what is known as the Labrador trough, the area of favorable rock is 225 miles long and from ten to sixty miles wide, with a productive zone known to be 90 miles long holding good prospects of extension at each end. On the Mesabi range, ore is covered generally by thick over-burden. In the Quebec-Labrador field, a large part of the ore forms surface outcrops; elsewhere much ore lies a foot or two below the surface.

So far, we have drilled and proven 418,000,000 tons of high-grade ore, more than 200,000,000 tons of which are within a radius of a mile or two of our base camp at Burnt Creek, located 360 miles inland from Seven Islands. During the summer of 1952, we intend to place in the field more than 350 men to undertake exploration and drilling in the outlying areas of the concessions. Preparing for that work, more than sixty engineers and geologists have been at work all winter at Montreal and at Knob Lake, plotting onto maps the findings from aerial magnetometer and ground surveys undertaken the summer of 1951. Thousands of square miles of favorable territory remain to be explored, and we know that the prospects for developing additional ore are excellent.

Indicating the wealth of these iron ore deposits are one or two incidents which have cropped up in the daily routine of our work. At one time, when we were bulldozing roads to some of the known surface deposits, high-grade ore was uncovered at a number of places within two feet of the surface. At another time, a new churn drill was set up for testing behind the machine shop at Burnt Creek and, by accident, ore was encountered when the drill was two or three feet below the surface. We decided to continue. Drilling went on to a depth of 367 feet and was still in high-grade when stopped. It was later found that the entire Burnt Creek base camp had been built over this particular ore body which contained more than 11,000,000 tons.

We know already that we will be able to supply almost any type of ore, ranging from lump to highly manganiferous. Of the latter variety, 44,000,000 tons so far proven will average 50 per cent iron and 8 per cent manganese.

So far, I have dealt only with the iron ore deposits. The method we shall employ to obtain the ore will be open-pit mining. We have already completed the detailed drilling for pit outline for the first three mines we intend to work. Our plans call for blasting the ore;

loading by 6-yard power shovels into 30-ton trucks and hauling to a crushing and screening plant in the pit. From that plant, the ore will be elevated by belt conveyors to railroad loading pockets. We plan to haul ten to twelve thousand tons per train, or from sixty to seventy thousand tons per day. At the port, a 1600-ft dock will be utilized to load ships at the rate of 8000 tons an hour, with large tandem car dumpers overturning two 90-ton ore cars every fifty seconds. From the port of Seven Islands, our ore will be transported to the markets we plan to serve.

From this brief description of the development, it will be seen that the proposition will end up largely as one of transportation. After the ore has been blasted in the open pits around Knob Lake, the rest of the operation will consist entirely of transport. All-important in our system will be the railroad between Knob Lake and Seven Islands, and our construction effort has been largely concentrated on that life-line. At the same time, other components of the construction system are going forward and, for the past two years, we have employed an average of 3500 men on our project. At the present time, the situation down there is as follows: Work on the railroad has been started at each end; that is, north from Seven Islands and south from Knob Lake. Grading on the first 110 miles has been largely completed and 30 miles at the northerly end is almost finished. This grading is well ahead of schedule. More than 40 per cent of the 14-odd million cu yd of rock and other material involved was excavated last year.

At mile 12, in from Seven Islands, a 2250-ft rock tunnel has been completed, and we have just started the only additional tunnel. This is at mile 65, and will be approximately 600 ft long.

A 700-ft steel bridge over the Moisie River at mile 12 was completed the middle of March, and foundations are being built for two more steel bridges, one 54 ft long at mile 31, the other 160 ft long at mile 41.

The Moisie bridge proved a bottle-neck in connection with track-laying operations last season, but with its completion we plan to lay a mile of track a day, and expect to be at mile 190 by the end of this year.

At Seven Islands, the freight yards have been cleared; between twelve and fourteen miles of track have been laid, and six diesel locomotives are already hauling materials for various purposes. Work is on schedule on the loading docks and 45 of the 75 projected houses in a workers' townsite are almost completed.

We are working on two hydro-electric power sites. One is on the Menihek River, 30 miles south of Knob Lake, the other on the Marguerite River, 20 miles from Seven Islands. In each instance, operations are on schedule.

Last reports show just over 3800 men at work, with 2300 on railroad construction, 350 on power sites, 250 on lumbering and tie-making, 215 on engineering crews, 100 on loading docks, 330 on miscellaneous construction and 150 overhauling equipment at the Knob Lake base.

While difficult of access owing to the terrain at the south end of the job, construction of the railroad does not entail grave engineering problems. For the first hundred miles north of Seven Islands, the track follows canyon-like river valleys to height of land at an elevation of 1900 ft. The remaining 260 miles are reasonably level. The maximum adverse grade against the load will be 0.4 per cent. On the plateau, old forest fires have destroyed practically all of the timber; but in the valleys, there is forest growth and we are obtaining all the lumber we need for construction purposes.

To sum up, some of our railroad work is ahead of schedule, and all of our other construction activities are on schedule. Let me emphasize that this rate of progress is due to the airlift we have operated from Mont Joli on the South Shore of the St. Lawrence, and from Seven Islands to the eleven airstrips presently in use. It is the world's largest civilian airlift and, last season alone, carried 33,000,000 lb of supplies and 22,246 passengers. The freight has included everything from beans to bulldozers; some pieces of equipment transported have weighed as much as fifty tons and have had to be shipped knocked-down and reassembled on the job. As the steel progresses, our transportation problem will lessen. Nevertheless, we are preparing, this summer, for the largest airlift activity we have yet undertaken. Fifteen aircraft will be in use.

In the light of our construction progress, it is now possible for us to say that we expect to start shipping iron ore in the late summer of 1954. Our operation plan calls for mining six months in the year; winter operation will be avoided because of ore freezing in the cars in transit. We will stockpile 2,000,000 tons at Seven Islands so as to extend the shipping season at the port which is free of ice at least nine months out of twelve.

Before we ship one ton of iron ore, we will have to spend some $200,000,000. At present, we have expended more than $50,000,000. To ensure a fair return on the investment of $200,000,000, we must mine and ship a minimum of 10,000,000 tons of iron ore per year. We hope, eventually, to increase our production and shipping to 20,000,000 tons a year.

Where will our markets be? In the first place, we cannot count on much from Canada at this time. In 1951, Canadian steel mills consumed approximately 4,900,000 long tons of iron ore, of which 4,700,000 long tons were supplied by Canadian mines already producing. That left a deficit of a mere 200,000 tons a year — hence my statement that there is virtually no Canadian market for us, because, under our plans, we could supply 200,000 tons in less than three days of mining. Obviously, therefore, for the time being, we must count upon the United States to absorb practically all of our production. Now, please do not imagine that we consider anybody has handed us our markets on a silver platter. Far from it. We will have to meet competition wherever we try to sell our iron ore. In the United States, we know that the Mesabi range, if diminishing in its reserves of high-grade ore, also holds billions of tons of taconites or lower-grade ores. And we know that a method has been evolved for treating those ores satisfactorily. We shall also face stiff competition from overseas ore-producing nations such as Venezuela, Liberia, Sweden and Brazil.

In these circumstances, you will appreciate that much of our success will depend upon our ability to lay down Quebec-Labrador iron ore at prices well within the current market. Hence our interest in the proposed St. Lawrence seaway. Here, allow me to emphasize one point. Our mines are not tied to the St. Lawrence seaway. We know that we will be able to produce and ship 10,000,000 tons a year even if the seaway is never built.

But, if our production is to rise to 20,000,000 tons a year — and a troubled world may demand that sooner than we dare believe — the seaway will be necessary.

No transportation problem exists in moving our ore from the mines to Montreal. At or near Montreal, we shall — in the absence of a seaway — trans-ship to existing "canallers," which can carry no more than a fraction of 10,000,000 tons a year, and also to railroads. Should there be a seaway, practically all ore for inland steel mills would move by water through to the Great Lakes. In this, the pattern of our ore transportation would follow that of Lake Superior ore. For many years, an average of 50 - 80,000,000 tons of ore have moved by water from the head of the Lakes down to lower lake ports serving the inland steel-making areas.

Conflicting interests have held up construction of the St. Lawrence seaway for many years. But the seaway, in peace and in war, is so vital in the opinion of Canadians, that the Canadian Government has now decided to build the route of its own accord should the United States still hesitate to participate. That is no paper proposition. The government at Ottawa already has formed a Crown company to see to the preliminaries of construction. And, in the final analysis, the actual navigation project is not so great in terms of engineering or dollars as we employ them these days.

At present, the St. Lawrence-Great Lakes navigation route provides 30-ft draft below Montreal, 14-ft draft between Montreal and Prescott, Ontario, and 25-ft draft above Prescott; including the Welland Ship Canal which Canada alone started in 1912 and which, when completed, allowed 25-ft navigation instead of the 14-ft navigation formerly existing between Lake Ontario and Lake Erie.

The big navigation bottle-neck now lies between Montreal and Prescott — a stretch of the river which has not been improved since 1900. Plain common sense dictates that this bottle-neck should be removed so that full advantage may be taken of navigational improvements already in effect both east of Montreal and west of Prescott.

A report issued by the General Engineering Branch of the Canadian Department of Transport in June 1949, estimated that, to complete the waterway for navigation purposes only, $350,000,000 would suffice. Of course, opponents of the seaway in any form prefer to talk about a billion dollar project; but the higher figure includes all power projects connected with the seaway; improvement of harbors on the upper lakes, and many other items which have no bearing on the actual cost of the canals and locks between Montreal and Prescott.

Whatever the controversial aspects of this long discussed seaway, one point permits of no argument. Canada intends to go ahead with the job. If the United States participates, so much the better, but the fast-expanding economy of this country, and the development of rich, natural resources in the extreme east and the extreme west of Canada demands that the seaway should become available at the earliest possible moment.

From time to time, there has been discussion of the possibility that the center of gravity of the United States steel industry might shift to the Atlantic coast. With the completion of the seaway, we do not foresee any such eventuality at this time. It is true that exhaustion of high-grade ores from the Mesabi range may be in prospect and those ores, of course, have been outstanding sources of raw material for American inland steel plants. The production of high-grade Mesabi ore will, we think, continue at its present rate for some years, then slowly decline. To supplement the dwindling Mesabi supply of open pit ore, it is evident that the main volume of our Quebec-Labrador ore will be marketed in that area of the United States where inland steel plants already exist. We will also ship from Seven Islands by sea to Philadelphia and Baltimore to serve steel mills on the eastern seaboard. And, until the St. Lawrence seaway shall be available, we will probably ship some ore to the Pittsburgh area via freighter to American east coast ports and thence inland by rail.

So far I have dealt with the construction of the St. Lawrence seaway purely from the economic viewpoint. There remains one other factor which, unfortunately, weighs heavily. I say 'unfortunately' because it deals with the possibility of war. In times of peace, American steel mills can count on ore imported from South America, Africa and some other lands. But experience of two wars and the information we already possess on war plans of would-be aggressors, make it clear that the sea lanes would become very hazardous and might possibly be closed should hostilities break out again. Then it is that the life of two nations — Canada and the United States — might well depend upon steel produced from iron mines located in what I might term our own back yard. But all of the iron ore in Quebec-Labrador would be useless unless it could be transported quickly and in volume to the steel mills. For that purpose, the St. Lawrence seaway would be invaluable and irreplaceable.

## SUMMARY

In the development of our $200,000,000 enterprise, we are a going concern. But our activities are far from complete. Last summer, for example, we discovered three new large ore deposits. We know we shall discover more during this coming summer. But, apart from our own particular enterprise, I visualize the northern terminus of our railroad as a point from which prospectors will radiate all over the vast territory of New Quebec and Labrador and locate and place in production the minerals known to be there. From first-hand knowledge, I can assure you that only a very small fraction of our northland wealth has been scratched and new mines will be found for many years to come.

Quebec-Labrador iron ore, plus the other minerals which will be found in the years ahead, will contribute notably to the economy of Canada and of the United States; and the St. Lawrence seaway will prove its value in both the economic and defense fields for the mutual benefit of the peoples of North America.

It is most gratifying that this vast enterprise in a remote section of Quebec and Labrador should have become possible through the association of Canadian and American financiers, and now the cooperation of Canadian and American talents and skills. Once the development period shall be completed, actual production will place valuable iron ore at the disposal of both our countries — one more bond between free peoples who must, I submit, stand shoulder to shoulder in a world faced with such grave international uncertainties.

# DEVELOPING

by G. D. TRANTER
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***. . . . the capacities of various operating units of the Middletown Division have been brought into a desirable balance with the new installations at this plant . . . .***

▲ IN describing new installations and developments for increased capacity, the program of expansion and modernization of Armco Steel Corp. is typical and comparable to that which has been going on throughout the steel industry to supply the unprecedented demand for steel, particularly during the past decade. The industry has not only made remarkable strides in production, quality and efficiency, but also in the rapidity with which new steel producing capacity and auxiliary facilities have been engineered, constructed and put into operation.

The subject matter of this paper is primarily a description of the new installations at the Middletown Division of Armco, and the sequence in which a program is being carried out to provide a well-balanced operation of steel melting, rolling and finishing capacities.

The program began some 12 years ago with the installation of the new slabbing mill and modernization of the existing hot strip mill. The new slabbing mill, designed to roll an entire ingot into a single coil, reduced the scrap loss, increased production and improved the quality, not only in the hot rolled band, but also in subsequent operations in other departments of the plant. Ingots are "spread" to width by cross-rolling on the slabbing mill, and only five ingot sizes are normally required for the production of strip, varying from 24 to 75 in. in width. The resulting increased capacity of the hot strip mill was followed by additional rolling, processing and finishing units, viz: a 54-in. four stand cold strip mill, a 54-in. 4-high temper mill to temper either coils or sheets, additional box annealing furnaces, and cut-up shears.

Steel melting facilities of the plant in the early 1940's consisted of eight open hearth furnaces tapping approximately 180 tons per heat. They had been remodeled and enlarged during the 1930's. Two blast furnaces with a capacity of approximately 775 tons each, located at Hamilton, eleven miles away, supply hot metal transported in ladle cars to the open hearth furnaces at the East Works. A coke oven plant which consisted of 85 ovens was later enlarged to 110, is also located at the Hamilton plant.

During the period of extreme demand for sheet products following World War II, the rolling capacity of the Middletown division increased to such an extent that it greatly exceeded the production of the steel plant. This was accomplished by adding new soaking pits, and making certain mechanical improvements in the hot strip mill where the delay reports indicated the need for improved engineering and maintenance materials.

Various plans for increasing ingot production were considered, and in April, 1948, a new electric furnace plant began operation. It consists of two electric furnaces with an estimated production of 18,000 to 20,000 tons per month. The electric furnace plant was built primarily because it was considered an economical method to supply more quickly a limited amount of urgently needed tonnage. Even with this additional ingot production, the rolling and processing units had developed sufficient excess capacity to convert a considerable tonnage of outside or conversion ingots into finished sheets and coils.

Analysis of the potential capacity of the Middletown division indicated that by additional improvements in the hot strip mill, the rolling production could be still further increased, with a consequent greater deficiency in the tonnage of ingots required. As the result of this analysis, the No. 2 open hearth plant was built and put into operation in October, 1950.

This increased melting capacity has created a temporary deficiency in hot metal which is being corrected by the construction of a new blast furnace plant to be completed the latter part of this year. It will consist of a 1450-ton furnace and 76 coke ovens. The completion of this new blast furnace plant, together with certain contemplated additions to the processing and finishing departments, will bring the capacities of the various operating units of the Middletown division into a desirable balance.

The foregoing is an overall summary of the program to-date, and the following detailed description of the various installations begins with the post-war period.

## SENDZIMIR COATING PROCESS

Following World War II, when construction materials were again available, the conventional method for making galvanized sheets was discontinued at the

# INCREASED CAPACITY

## AT ARMCO'S MIDDLETOWN DIVISION

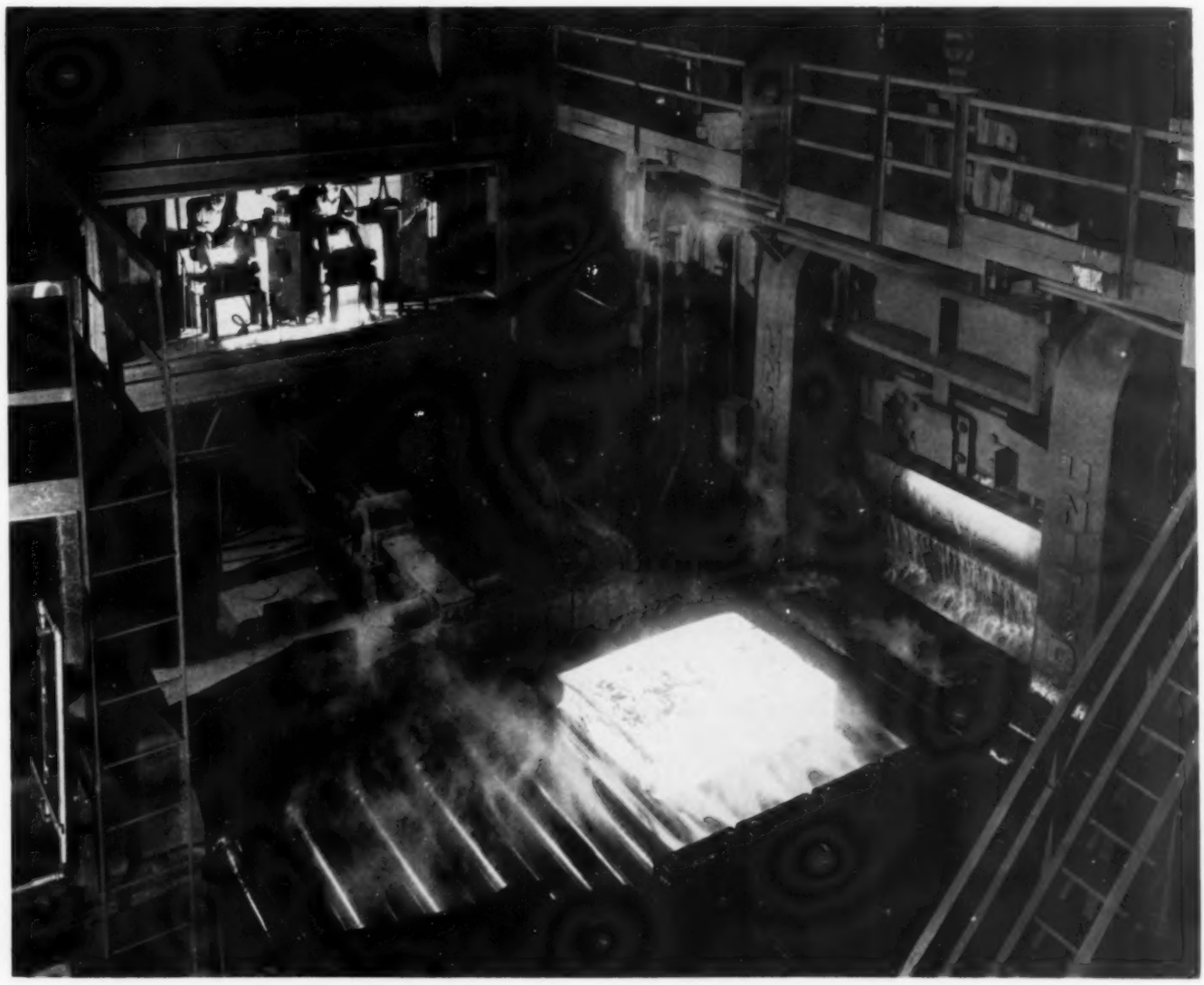
Middletown division, and two continuous coating units, based on the Sendzimir coating process, were installed. The process has been in operation at the Butler, Pa. division of Armco Steel Corp. for 16 years.

Surface preparation of the base metal, is accomplished by the process in two steps: (1) oxidation of the surface, and (2) subsequent reduction of this oxide.

Oxidation by controlled heat is used, and rolling lubricants and other combustible material are thus removed. The full hard, cold reduced material, generally used in the coating process, is annealed simultaneously with the reduction of the oxidized surface. The reducing and annealing operations are controlled by the furnace atmosphere and temperature. Dissociated anhydrous ammonia — 75 per cent hydrogen — 25 per cent nitrogen (by volume) — serves as a satisfactory reducing atmosphere during annealing and as a non-oxidizing atmosphere in the cooling furnace.

Equipment on the feeding-end uncoils the incoming strip, feeding it into the coating line at a designated

**By cross-rolling on the slabbing mill ingots are spread to the desired width. Thus, only five ingot sizes are normally required for the production of strip of 24-75 in. in widih.**



constant speed under specified tension. It also allows for joining the coils without affecting the speed of the unit.

The preheating furnace preheats the strip uniformly to a designated temperature, and a controlled firing pattern is used so that uniform oxidation over the width of the strip is maintained.

The annealing furnace, placed in line with the preheating furnace, completes the heating of the strip under a reducing atmosphere to the annealing temperature. Gas fired radiant tubes or electric elements, driven hearth rolls of a suitable alloy with properly sealed bearings, and automatic controls are features of the annealing furnace.

The cooling furnace is directly connected to the annealing furnace and extends to the zinc bath with its end sealed by the molten zinc. The purpose of this furnace is to control the cooling rate of the strip in a non-oxidizing atmosphere.

An electrically heated furnace surrounds the zinc bath and supplies the heat for controlled melting of the zinc and the necessary heat for maintenance of a uniform zinc temperature during normal operating conditions. Only a small amount of additional heat is required as practically all of the heat necessary is supplied by the incoming strip.

Exit rolls, common to sheet galvanizing operations, serve as a means for regulating the weight and uniformity of the coating. No flux is required on the surface of the bath to maintain a bright and uniform coating on the rolls, and the service life of the exit rolls is 10 to 12 days between re-dressings. It is only necessary to dross the kettle four times a year.

Roller levelling, oiling, inspection, stencilling, coiling and shearing equipment are incorporated in the unit. Except for grades requiring special surface treatment, practically all of the coated material is ready to ship as it leaves the coating line.

## ELECTRIC MELTING DEPARTMENT

When the demand for more steel continued after the end of World War II, it became evident that additional steel melting capacity was needed at the Middletown division. During the war some consideration had been given to additional melting capacity and studies had been made of the relative merits of electric melting furnaces and open hearth furnaces.

These studies were reviewed and brought up to-date, and it was decided to install electric furnaces because of the time element in getting them into operation and the lower installation cost. Another consideration was the fact that all of the additional production would have to come from scrap, since the open hearth shop was taking all of the hot metal available from the Hamilton blast furnaces. Any hot metal thus diverted would reduce their productive capacity, and the iron so lost would have to be replaced by additional scrap. The electric melting process is much less oxidizing than the open hearth and better adapted to the melting of the high scrap charges.

Therefore, it appeared to be the best choice for handling the raw materials available at the time.

In 1947 a new electric melt shop was constructed as a separate unit on the south side of the East works plant. The furnaces began operation in April 1948. This shop is a complete unit with its own stockyard and service facilities, but the ingots are transferred to the stripper yard serving No. 1 open hearth department for stripping.

The shop contains two 70-ton electric arc furnaces with 20-ft shell diam, and 17 ft 9 in. diam inside the 12½-in. lining. The bottom is 28 in. thick, consisting of 7 in. of rammed magnamix, 15 in. of magnesite brick, and 6 in. of clay brick. There are three 20-in. diam graphite electrodes equally spaced on a 5-ft circle. The furnaces are side charged with a 7½-ton low type charging machine. The charging buggies hold four pans of 35 cu ft capacity each.

The transformers and controls for both furnaces are enclosed in a brick building between the two furnaces. Each furnace is powered by a 15,000-kva, 3-phase, 60-cycle transformer receiving power at 13,200 volts from an outside substation fed at 66,000 volts.

The furnaces are normally used to melt carbon steel, but occasionally alloy steels are made. Although rated as 70-ton furnaces, the average tons per heat is 105 net tons. The average tons per furnace hour is 13.84 with a power consumption of 495.5 kwhr per net ton of ingots.

The installation has been very satisfactory with respect to type of product and steel quality.

## NO. 2 OPEN HEARTH DEPARTMENT

As the demand for steel continued to increase, it was decided in 1949 to install additional melting capacity. Scrap was becoming more scarce and it was evident that much of the increased steel production must come from ore and hot metal instead of steel scrap. Although much additional ore was not immediately available, the development of new ore fields in Labrador and South America and the progress being made in the pelletization of the Minnesota taconites, indicated that ore supplies could be materially increased in the next few years. It was, therefore, decided to obtain additional melting capacity from open hearth rather than electric furnaces.

Since there was not sufficient iron ore immediately available to supply another blast furnace, it was decided to postpone the construction of the new blast furnace and start the additional furnaces on a low hot metal high scrap charge, by diverting some hot metal from the present furnaces. It is common knowledge that delays and interferences due to charging are among the principal factors limiting open hearth production, therefore, the high scrap charge with present grades of scrap presented a critical charging problem.

During the early engineering stages of No. 2 open hearth, an unscheduled furnace repair in No. 1 open hearth department, resulted in two adjacent furnaces being down at the same time. Attention was then focused upon fast charging of the furnace at the end of the shop; not in quality and average weight of the scrap iron, but in greater speed of delivering and charging the scrap into the furnace. This made a substantial increase in tons per hour, stimulating the thought that a different method of delivering the charge to the furnace should be developed. The production of individual furnaces could be materially increased if such

**View from crane operator's cab shows tapping of one of the three 250-net ton open hearth furnaces in the new open hearth shop.**

a method would result in rapid charging and no interference with the operation of adjacent furnaces.

Considerable study was given to improving the methods of charging open hearth furnaces, resulting in a radically new charging practice suggested by E. N. Millan, Armco's chief engineer. Instead of switching drags of charging buggies up an incline, to the charging floor or from an elevated stockyard, the drags are brought in at yard level under the charging floor. The tracks at yard level are at right angles to the furnaces and are connected by curved tracks to the stockyard some distance away. Scrap hoists, each holding one charging buggy, are provided at each end of the furnaces, and individually loaded buggies of the drag are hoisted from yard level to the charging floor. The scrap is charged in the normal manner by a conventional charging machine, and the empty buggy is placed on the scrap hoist at the other end of the furnace for return to yard level.

Tracing the operation of this new charging system, a locomotive pushes the loaded drag of charging buggies from the stockyard to the rear basement of the open hearth building on a track which curves away from a ladder track parallel to both the open hearth furnace building and the stockyard. The locomotive is uncoupled and the front buggy of the drag is engaged by air operated "dogs" on a heavy chain conveyor drag haul with a reversible adjustable speed of 3 to 12 fpm, and pulling capacity of 40,000 lb. The drag haul moves the drag slowly forward until the front buggy is in position to engage an air operated "dog" on a motor driven car called a cager, which has a speed of 60 fpm. The buggy is uncoupled from the drag and the cager pushes it rapidly onto the scrap hoist platform.

The scrap hoist platform is 19 ft 4 in. long and 10 ft wide, with a standard gauge track running its entire length. Each rail has raised humps welded on the head to position the car on the platform. In the down position, the track is in line with the drag haul track perpendicular to the line of the furnaces. As the platform is raised it is automatically turned 90 degrees by a stationary helical cam engaging guide rollers on the platform, so that in the up position it is in line with the charging track in front of the furnaces. The platform is raised by a 22-in. diam plunger with 300 to 350 psi hydraulic pressure, supplied by a separate pump for each scrap hoist, in a closed recirculating system. The hydraulic fluid consists of water with the addition of soluble oil to prevent rusting.

The hoist capacity is 83,400 lb with a lift of 20 ft 6 in. The hoisting cycle with a normal loaded buggy weighing 45,000 lb is 120 sec.

When the loaded buggy is raised to the charging floor, the charging machine engages a pan, moves the buggy to the furnace, charges the scrap into the furnace and moves the empty buggy to the scrap hoist at the other end of the furnace. The lowering cycle of empty buggies, weighing 30,000 lb is 104 sec.

When the empty buggy reaches the down position, the cager removes it from the hoist platform and places it to engage the "dogs" on the drag haul. Succeeding buggies are automatically coupled to those ahead until the empty drag is completed for return to the stockyard.

The drag hauls, cagers, and raising of the scrap hoists are operated from push button control stations in the basement, near the down position of the scrap hoist. The lowering of the scrap hoists is controlled by the charging machine operator. Automatic mechanical stops and limit switches are provided to prevent over-travel, and emergency stops were installed for safety reasons. The controls of the cager and scrap hoist are interlocked to prevent either from operating unless the other is in the proper position. Automatic safety gates are provided at the down-and-up positions of the scrap hoists to prevent anyone from falling into the wells when the platform is at the lower level.

The charging method has worked out very satisfactorily. No serious difficulties have developed and mechanical, electrical, and hydraulic delays have been very few. Interference with the operation and repair of furnaces adjacent to the one being charged has been practically eliminated.

The new open hearth shop is complete and self contained, with the exception that ingots are transferred on buggies to the stripping yard in the old plant for stripping, heating and rolling.

The stockyard building is parallel to the main furnace building, and is 607 ft long, 80 ft wide and served by two standard 15-ton overhead traveling cranes.

The main furnace building is 513 ft long, with a 64 ft 6-in. ladle crane spanning the pit, an 80-ft hot metal crane spanning the charging floor, and a 21 ft wide lean-to adjacent to the charging floor. The furnaces are spanned by heavy crane runway girders 108 ft long, 12 ft deep, and weighing 92 tons each. They are supported on columns at the ends of the furnaces, so that

there are no intermediate columns to interfere with tapping or removing slag.

The entire charging floor system is completely independent of the building steel so that expansion in the building steel will not push the openings in the floor system out of line with the scrap hoist platforms. There are expansion joints between the sections of the floor in front of the furnaces and the floor opposite the hoist openings. The supports for the separate sections are so constructed that expansion occurs equally on both sides of its center line toward the adjacent section. By this method, it will be reasonably certain that expansion will be localized at definite points where comparatively simple expansion joints can be provided.

A standard gauge track for charging buggies extends the length of the building in front of the furnaces. Two 12-ton, high speed, 900 fpm, charging machines run on a 26 ft 6 in. gauge track.

There is sufficient space on the floor in the rear of the charging machine for a hot metal ladle car track when more furnaces are added.

The ladle crane in the pit has a 300-net ton main hoist, one 60-net ton and one 15-net ton auxiliary hoist. In order to reduce the load on individual wheels, this crane is equipped with 24 bridge wheels.

Hot metal is brought in from the blast furnaces at Hamilton in mixer cars, at yard level. From these cars it is poured into 100-ton transfer ladles resting on a 150-ton scale in a pit 25 ft deep. A 150-ton hot metal crane delivers the hot metal to the furnaces.

The furnace building contains three 250-net ton open hearth furnaces with isley controls. The hearth, inside the brickwork of each furnace, is 18 ft wide by 53 ft long, giving a hearth area of 954 sq ft. The depth of bath is 31½ in. The overall length of each furnace, outside the brickwork, is 84 ft and the overall width outside the brickwork is 21 ft at the ends and 24 ft 3 in. at the center due to the sloping backwall. The main roof has a span of 22 ft and a rise of 3 ft 2⅜ in.

The furnaces have basic ends, with the port roof uptakes and slag pockets to the top of the false wall constructed of suspended basic brick 13½ and 18 in. thick.

The fuel consists of either Bunker "C" fuel oil or a combination of fuel oil and gas. A water jacketed artillery type burner extends across the single uptake to deliver the fuel. Fuel oil at 180 psi, and 190 F, and natural gas at 40 psi are supplied to each furnace. Superheated steam at 165 psi is used for oil atomization.

North of the west end of the furnace building is an overhead bin system for storing burnt lime and burnt refractories. The bins discharge above charging floor level and can discharge into pans on charging buggies or into the hopper of the dolomite machine for making bottom. The bins are filled by an inclined belt conveyor from a covered track hopper at yard level into which hopper cars can be dumped.

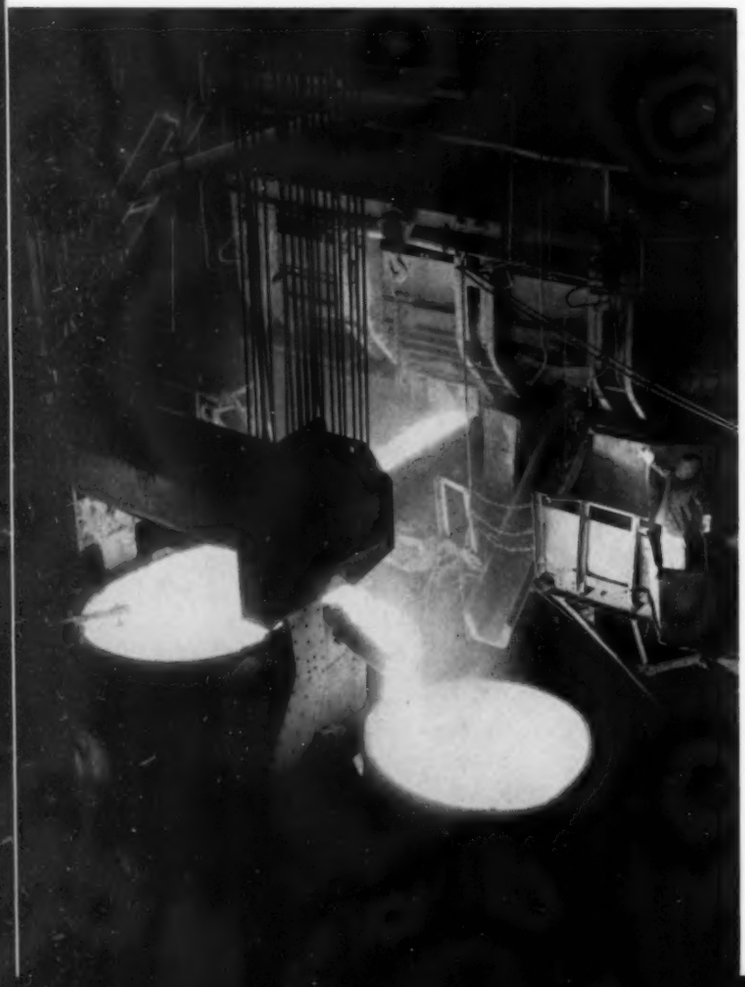
Miscellaneous materials are handled by lift trucks and tote boxes or pallets. A ramp is provided at the west end of the building to permit lift trucks and regular trucks to travel between the charging floor and yard level.

The mold cleaning, preparation, and storage building is equipped with one 20-ton standard overhead traveling crane with an auxiliary hoist.

The service buildings for the shop include maintetenance headquarters, laboratory, electric control station, water cooling tower north of the furnace building lean-to, with the open hearth office at the southwest corner of the main building.

The performance of the shop has been very satisfactory. With 25 per cent hot metal and a fuel consumption of 3,250,000 Btu per hour, the production is 19 tons per furnace hour. The three furnaces have produced over 40,000 net tons of ingots in a single month.

**The pit ladle crane has a 300-net ton main hoist, one 60-ton and one 15-ton auxiliary hoist.**



## HOT STRIP MILL REBUILDING PROGRAM

Anticipating additional ingot production when more hot metal is available, further improvements were made in the hot strip mill during the past year. A new row of soaking pits was constructed, the existing slab furnaces were rebuilt, and a fourth slab furnace was added. New and heavier equipment was installed in the finishing train, viz: drive motors, back-up and work rolls, screw-downs and screwdown motors. While the foregoing represents the principal changes, other weak spots were rebuilt including certain mill tables, one coiler was replaced with a heavier design, new chutes and loopers installed, together with complete new pipe lines for compressed air, hydraulic water, steam, and mill water systems. Much of this work was completed without interruption to the rolling schedules, but the replacement of the mill housings, pinion stands, chutes loopers and the new foundations required a complete shut down.

Obviously, a job of this scope required considerable planning prior to the actual installation of the various

units. A work chart, timetable, and sequence of each element of the job were necessary to properly expedite the work. The work chart was divided into two-hour work cycles, thus making it possible for the engineers and expediters to know at all times whether the projected work schedule was being met.

The safety features of the job were given the same attention as the engineering and work schedules. About 350 men were employed around the clock for the duration of the job, and completed the project without a lost time accident. The mill was shut down for the rebuilding on January 2, 1951, and was again rolling strip on January 14, or a total of 12 days to complete the project.

Three new 4500-hp motors were later installed which also involved the relocation of other motors, in the various stands, to place them in the proper sequence. With one exception, all of the motor changes were made within the routing weekly repair period.

## BLAST FURNACE

The new blast furnace and coke oven plant is now under construction south of No. 2 open hearth shop. The present blast furnace plant at Hamilton is too congested to permit further expansion and there will be considerable economy in avoiding the cost of transporting hot metal and coke oven gas from Hamilton to Middletown. Provision is made for the hot metal from the new furnace, as well as that from the Hamilton blast furnaces, to be used in either No. 1 or No. 2 open hearth shop as needed. The coke oven gas will be used for mill reheating furnaces and for open hearth melting. Construction of this plant was started in February 1951 and it is expected to be in operation late in 1952.

The blast furnace will have a hearth diameter of 28 ft, stock line diameter of 21 ft, and large bell diameter of 15 ft 5 in. It will be 104 ft high from iron notch to top ring, with a revolving distributor top, and a working volume of 45,500 cu ft. It will be blown by a 110,000 cu ft per min steam driven turbo blower at 35 psi pressure with 30-in. mercury pressure and 60 F air inlet conditions. The furnace is equipped for high top pressure operation.

The ore yard is 700 ft long with a storage capacity of 700,000 tons of ore. The ore bridge has a span of 285 ft and is equipped with a 15-ton bucket. The ore bridge has Ward-Leonard controls. The raw material handling facilities also include a stationary car dumper.

The stock house contains two coke bins, two stone bins, ten ore bins, and two miscellaneous bins, all served by three high line tracks. The scale car has a capacity of 30 net ton or 500 cu ft.

The instrumentation of the furnace will cover every phase of its operation, and will be as modern and up-to-date as it will be possible to install. The furnace is expected to produce 1400 to 1500 net tons of hot metal per day.

## COKE OVENS

A new battery of coke ovens and a by-product recovery plant is being built adjacent to the Middletown blast furnace to supply the coke. The coke oven battery consists of 76 underjet, four-divided, low differential ovens. The ovens are designed to carbonize a coal mixture of 80 per cent high volatile and 20 per cent low volatile coal at a maximum coking rate of 16 hours when underfired with coke oven gas having a calorific value of 550 Btu per cu ft. Coal carbonized in the battery will be 2075 net tons per day.

A tar processing plant will be built to produce a pitch suitable for open hearth fuel. Final plans for the recovery and disposition of other by-products have not been completed at the present time.

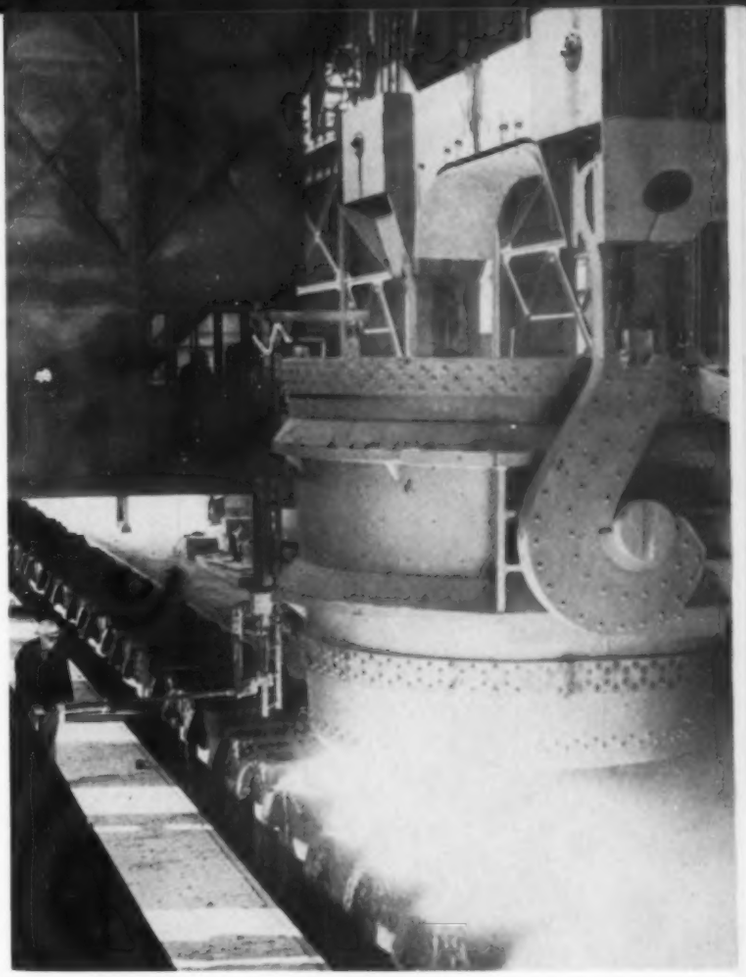


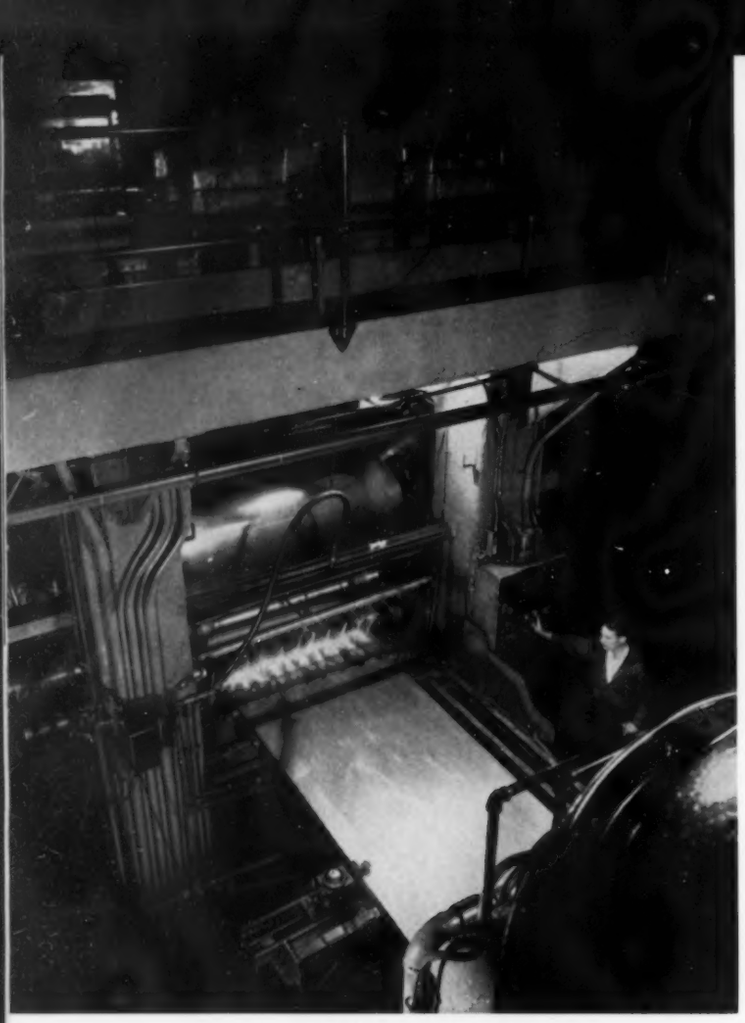
**Illustration shows ingots being poured in new open hearth shop.**

## TRAINING

Buildings and equipment are essential factors in modern industry, but it takes well-trained and enthusiastic personnel to obtain maximum results. A special training program was conducted prior to the installation of the new galvanized coating units, the new open hearth department, and now preparations are being made for setting up a training program for the new blast furnace personnel.

The training program for the new coating units was planned to coincide with the construction schedule. Operating and maintenance foremen, who were to supervise the equipment, together with certain key personnel were given special training in the technique of operation and maintenance.

The practical training program was augmented by classroom discussion on the details and fundamentals of the practice.



Cold reduction mill.

As the result of this training program, the first coil made on the unit was prime material and shipped to the customer.

The open hearth training program was likewise beneficial. First and second helpers together with certain other key personnel were included in the special training course. The program not only covered the practical features of the various open hearth operations but also the fundamentals of open hearth practice, elementary chemistry, principles of combustion, and furnace design.

The actual training was done by selected members of the open hearth, combustion, metallurgical, and training department organizations. A melter who had recently retired took part in the training program. He coached and taught the younger men the practical features of furnace operation.

Other training programs of a similar nature have been carried on in various parts of the plant where new equipment has been installed. The overall results have been extremely satisfactory, and the cost of the training program has been fully justified by the results obtained.

## CONCLUSION

Armco's modernization and expansion program closely parallels that of the industry. Continued expansion will undoubtedly depend largely upon the trend of economic conditions, as well as the industry's ability to absorb additional corporate tax burden.

Since 1946, when the nation's steel capacity was rated at close to 92,000,000 tons per annum, the industry has, on its own initiative and risk, increased this figure by 18.2 per cent to a total of 108,600,000 tons. By the end of 1952 it is estimated that the industry's rated capacity will be in the neighborhood of 118,000,000 tons of ingots.

To obtain this increased capacity, the industry, since 1946 to the end of 1952 will have spent roughly $4,700,000,000. It is estimated that of the $3,100,000,000 net profit of the industry during this period, some $1,800,000,000 or 57 per cent of these earnings have been re-invested in the business, the major portion of which has gone into the construction program.

The re-investment of this amount of money back into the business is evidence that earned profit is the paramount incentive in the accomplishment of future modernization and expansion. The greatest threat to this incentive is progressively higher taxation. If progressive taxation continues, there will be less incentive to risk available funds as venture capital.

Unquestionably, the industry will continue to meet the demands of national defense, while at the same time making every effort to fulfill the needs of the domestic economy. However, in order to maintain the incentive of the free enterprise system, it becomes increasingly imperative that a remedy for free spending — the forerunner of excessive taxation — be found.

There must be a greater realization that prosperity cannot be legislated, and that progress is achieved only by individual and collective initiative.

When these principles are once again established as the guideposts of our national economy, we can, as a nation and as an industry, face the future with greater confidence.

# DISCUSSION


PRESENTED BY

**H. J. LEAVER, Staff Engineer, Rolling Mills, Jones & Laughlin Steel Corp., Pittsburgh, Pa.**

**L. F. COFFIN, Assistant General Manager, Bethlehem Steel Co., Sparrows Point, Md.**

**G. D. TRANTER, Manager, Middletown Division, Armco Steel Corp., Middletown, Ohio.**


**H. J. Leaver:** This paper has revealed a program of planning and development which has been duplicated to a varying degree by practically all steel producers in the United States during the last few years. An overall view of this program indicates the steel producers' interest in contributing to the development of our American standard of living and in some cases to the program of rehabilitation of other free countries of the world. The preeminence of American methods and rates of production among the nations of the world indicates that this has been a job well done.

This paper has indicated to all of us the importance of a long range planning program to be sure no blind alleys are entered in doing this work. This calls for top management decisions setting the general scope to be achieved, backed up by engineering investigations to determine the practicability of proposals made, both from an economical and a workability standpoint. This is the only way in which such items as product flow, transportation, storage, and space for necessary auxiliaries required for successful operation can be predetermined. Top management planning and authorization for necessary investigations is a must as the ultimate success of any enterprise depends upon their ability to foresee future as well as present conditions. The present conditions existent in our country do not make this an easy job. The paper also indicates the need for new ideas and new methods. Today's new idea becomes tomorrow's obsolete method.

The section devoted to a discussion of the planning of the actual construction work is of particular interest to engineers. All of us at one time or another have had the job of planning all or part of such programs. The time required for careful planning and preparation pays big dividends in time required to get main units in operation without undue delays and in a safe manner. I believe we of Jones & Laughlin, as much as anyone in the country, realize this because of our recent experiences in carrying out major construction projects without interferring with the operation of our existent mills. Actual construction costs are greatly influenced by the extent of the planning for these projects.

The section on training of new and old employees for the operation of modern equipment is also very interesting. Present day complexity of equipment rules out the old practices of long break-in periods with the operators gradually absorbing and understanding of the equipment. Today our methods of operation will not permit wide variation in operator technique if the equipment installed is to produce as intended. We must have our procedures well planned before starting equipment, and see that procedures are followed by all in a uniform manner. A failure to do this can sometimes cause "pegged production" by operators who set a production pace based upon inefficient methods, thereby cancelling out a lot of the productive capacity that was engineered into the equipment.

I believe the author saved his real punch line for the last two paragraphs of his paper. I quote, "There must be a greater realization that prosperity cannot be legislated, and that progress is achieved only by individual and collective initiative. When these principles are once again established as the guide posts of our national economy, we can as a nation and as an industry, face the future with greater confidence."

Events of the last month clearly indicate that those in our government who should be the most outstanding advocates of free enterprise in America do not believe the quotation above has any merit. I do not like to think of the future for my two sons if their progress is limited by how they vote.

**Louis F. Coffin:** We are all indebted to Mr. Tranter for a very clear and interesting discussion of the facilities of Armco at Middletown. His discussion of training was particularly interesting. Certainly, as the years go on, operating personnel must secure more and more training. There has been quite a little done in the training of maintenance forces, as of course the apprentice system for craftsmen has been in operation for years throughout this country, and other programs for repair forces have been instituted. I am glad to see that Armco is taking a lead in training for operators. It would be most interesting if he would elaborate on some of the details of the training program for operating personnel.

**G. D. Tranter:** We have our training program under the direction of a training advisor, and the various training activities where new equipment is involved are headed up by the training department. However, the responsibility for carrying out the training program and getting results rests entirely with the operating and maintenance supervision.

The actual work of teaching the technique of the job is augmented by a certain amount of classroom work. In other words, we try to give some of the theoretical as well as the practical aspects of the job.

In the case of the open hearth training program, a certain amount of elementary metallurgy was included in the course. We also taught the fundamentals of the economics of the business. We have also tried to point out the need for making the most out of the new equipment so that we do not translate the limitations of the old equipment into the new.

The training program used in our open hearth department included first helpers, second helpers, slag notch people and others. Of course, these men had some previous open hearth experience because the men who became first helpers in the new shop either came from our electric melting department or from No. 1 open hearth.

In the classroom work, for instance, we had about two hours of the fundamentals of open hearth practice. We had four hours of elementary chemistry pertaining to open hearth operation, and it was surprising how much the men understood and became familiar with. We also had five hours in combustion, types of fuel and the safe and efficient use of fuels.

The fundamentals of economics applied to actual operations in which costs were interpreted in terms of tons per hour, manhours, Btu per ton, yield, waste of materials and supplies. Furnace maintenance and repairs were carefully explained, together with a general outline of the purpose and use of various refractories. A general discussion of operating problems followed which required several hours.

As the result of thorough training, the new open hearth department started out at the rate of nearly 19 tons per hour with only 26 per cent hot metal.

We had a similar training course for the Sendzimir coating unit. In this case we did a certain amount of on-the-job training at our Butler, Pa. division, inasmuch as we had a unit at that plant which had been in operation for a number of years.

We believe these training programs are very important, and that we cannot leave the matter of learning the job to chance and expect the people to pick it up the hard way. Possibly you and I may have learned it that way, but we cannot follow such a long and expensive procedure in this modern age.

By CARTER KENDALL, Chief Safety Engineer, Compensation and Safety Department, Bethlehem Steel Co., Bethlehem, Pa.

# Accident Control in Rolling Mills

***. . . . an active and dynamic safety program will pay off in saving of lives and prevention of human suffering . . . .***

▲ THERE are many basic facts about the operation of rolling mills that are so well known that they are accepted as fundamentals, and it is only necessary to mention them to arrive at complete understanding about what is meant. At the mere mention of guide setting or roll changing, for example, a complete mental picture flashes into mind. This will include the equipment involved, the procedures followed, and even the personnel required to execute the assignment. No elaborate or detailed explanation is needed to establish a common plane of conversation, nor is it necessary to convince any one of the essentials, because years of operational experience have endowed you with comprehensive information on such subjects. But if you wish non-operating people to gain even a fair proportion of the knowledge you possess and to understand your problems, it is necessary to start with fundamentals and explain the reasons why guides must be set, why rolls must be changed, and to explain or demonstrate the various steps involved. There is nothing unusual or peculiar about this. It applies to every activity in every specialized field. It is certainly true in accident control activities.

To anyone who has devoted much time to safety, the inter-relation of safety and production is accepted as basic to accident prevention work. Many of you are well aware of this, else the outstanding safety records that have been built up through the years could not have been realized. It is to be hoped that this paper will add force and substance to the accident prevention activities in your own departments during the months that lie ahead by refreshing your minds on the fundamentals involved.

The instant production starts in any shop or department, many sometimes vexing problems arise. Maintaining proper rolling temperature, maintaining the section within permissible tolerances, producing the optimum in surface, making maximum use of manpower, proper training of all levels of personnel, and coordination and cooperation with other departments are a few of the problems that must be solved if maximum tonnage at minimum cost is to be attained. Many of these problems are introduced at the start of operations; others introduce themselves at various times in the production schedule. The successful solution of all such problems is the test of capable and efficient management.

But when do we introduce accident control into the production picture? The answer is "Never"! If we are going to have safe working practices and conditions, safety must be part and parcel of the operation from the start. One might as well ask a man at what time in life he obtained his good right arm. If he has it at all, he had it from the start. But he can lose it if he does not exercise due care. He cannot save it by not using it because it will atrophy and wither away. He must exercise it constantly. There must be effort put forth and energy expended from day to day.

But to resolve the metaphor, even though a safe layout is built, machine guards installed where necessary and proper consideration given to safety at the start, not a single one of the "vexing problems" will be solved unless there is a constant, sincere and conscientious effort put forth to maintain and strengthen the accident control activities, all along the line.

An accident can be defined as an event that was not planned to take place. Let's toss a few "unplanned events" into the group of problems that were mentioned just now, and see what effect they would have on production. Suppose that for any one of a variety of reasons, the temperature is off and relatively cold steel hits the rolls. Who is going to be hit by what, and how hard? What will be the down-time on the mill?

Suppose the guide setting is off and a cobble results. How much production time will be lost clearing away the cobble and who will be injured?

Suppose that an unplanned event takes place in another department — the next in the production line so that movement of steel is temporarily suspended. Your hot bed is full — what happens to your tonnage?

Now I am sure that no one will have to stretch his imagination very far to visualize happenings such as these. Nor will he have to look very far to find the cause of these events. Human failure somewhere along the line lies back of most of them. Somebody failed in getting proper temperatures, somebody failed to check the guide setting, somebody failed in another department in some way or other, and your production suffers for it. Could improved coordination and cooperation have changed the picture in this last instance? It is likely.

But one thing is undeniably true — production has suffered because of an unplanned event — an accident. Was someone hurt in the accident? Very likely. But whether or not someone was hurt, the real problem is the same, the basic causes are the same and the cure is also identical. The accident control program did not function as intended.

It has been well accepted among safety engineers that three conditions must be established before an accident control program can be considered to be effective. They are:

1. Positive interest on the part of the men. (This sometimes entails the overcoming of passive resistance.)

2. Full supervisory cooperation.
3. Adequate training of personnel.

It is not at all coincidental, that these same three factors are also essential to good production records. The two go hand in hand. In fact, unless the accident control work is integrated with production, maximum results will not be attained in either.

The accomplishment of these three objectives is never easy. There is no prompt solution to any of them. Hard conscientious and sincere work is demanded, but such assignments have always been accepted by steel men so I am sure that our industry can be depended upon to solve these problems.

Possibly it might be helpful to suggest a well planned course of action based on what has been proven to be very beneficial. Job Safety Analysis offers one method of attack that is quite easy to install, is readily understood and is not so complex in functioning as to cause it to bog down under a mass of detail. A "job" in this sense generally means the performance of any task that is expected of an individual worker, or it can apply to the coordinated work of a gang or crew of men such as takes place when rolls are changed or when a cobble must be cleared up. The job is broken down into its elements with each step clearly but briefly described. These elements are listed in a column on a sheet of paper. Opposite each element the hazards associated with it are listed and opposite each hazard the controls that are or should be applied are recorded. This analysis is not made by the safety department personnel (although they will be glad to help), but rather by the foreman on the job. He must do this for reasons which will become obvious. He should have the most intimate knowledge of each step in the production picture. He should know best just which phase is handled by which man or men and the hazards associated with it. He should know or perhaps will have to learn the controls to apply to offset the hazards. If he has to learn something about the analysis of any job, then the plan is doubly beneficial. Foreman training is added, with no additional time consumed.

The Job Safety Analysis technique should be applied to every job in the production picture. It cannot be done overnight nor even in a month. It will take time, but to accomplish its purpose it must be thorough and complete. Once started, more and more instances will arise where a change in the production procedure will eliminate certain intermediate steps and the hazards of them, thereby benefiting both production and safety. Positive interest on the part of workmen will be built up by the discussions the foreman will have to hold with the men in relation to the details of the jobs. They will feel drawn into more intimate relationship with the department and its operation. Along with this reaction will go a greater natural tendency for cooperation and the whole program, as soon as the first analysis is completed, provides an expanding collection of data for on-the-job training in production and safety that is without peer. No text book ever written can approach this, because no text book can be written to cover specific jobs in your own department.

After all jobs in the mill have been analyzed, if it is desired, they could be combined or blended into a study of the operation of the entire department. Foremen on different turns could be asked to prepare analyses on the same jobs for each turn, and comparisons made to improve supervision, production and safety.

And how about the immediate future? How many green men will be employed before the present operating conditions become history? Could you ask for a better training guide than you will build by such a program as this?

Now lets make an assumption. Let's assume that complete job safety analyses have been made on all jobs in your department but men are still being injured. What should be done? After the case has been thoroughly investigated and the causes determined look over the J.S.A. for the job on which the man was injured, and try to determine what had been overlooked as a hazard or had not been tried as a control. Perhaps the study will disclose that instruction on the job was weak in some particular, and that some things that should have been stressed have been overlooked. Then revise the J.S.A. accordingly and extend the same revision to the analyses of all similar jobs where the same or similar hazard is encountered. This will keep your program alive, active and progressive, which it must be to be successful.

It is a proven and accepted principle of modern accident control that individualized instruction by the foreman on the job produces the greatest results in the shortest time. It is a fine thing to accept and apply such a principle, but what is the foreman going to talk about to his men? We find that the Job Safety Analysis provides him with all the material he can use in such a program. He is bound to endorse it heartily because he himself prepared the analyses.

You will recall that the word "attack" was used — "accident control" was emphasized and just now I said "active and progressive." Your program must be all of that. It must be active, it cannot be passive, it must be dynamic, it cannot be lethargic, and your pay off will be in the saving of lives, the saving of limbs and the prevention of human suffering of all degrees. And as a collateral benefit, watch your production climb as your overall accident experience improves.

## DISCUSSION

PRESENTED BY

**R. W. DICKSON, Assistant Division Superintendent, Central Mills, United States Steel Co., Gary, Ind.**

**R. W. Dickson:** We at Gary Steel works concur with Mr. Kendall that individualized instruction by the foreman on the job produces the greatest safety results in the shortest time. As a program comparable to the Bethlehem "Job Safety Analysis," we of U. S. Steel have the "3 C's of Safety." This is the second phase of a safety plan which follows and supplements "Single Objective Safety." The "3 C's of Safety" is designed to develop further that all important awareness which leads to accident prevention. It is aimed at the elimination of injuries and emphasizes a comprehension of the possibilities of injurious contact and their control. Thus, the three C's, are Comprehension, Contact and Control.

# MODERN CRANE CONTROL FOR STEEL PLANTS

*. . . . constant improvements are being made in crane control . . . both in a-c, which is used in general industry, and in d-c, which is the favorite of the steel industry . . . .*

## ALTERNATING CURRENT

By W. R. WICKERHAM
Control Engineering Dept.
Westinghouse Electric Corp.
Buffalo, N. Y.

▲ THE solution of problems attendant to obtaining ideal crane hoist performance from alternating current motors has constituted an engineering challenge for a long time. The difficulty, as stated in non-technical language, is the fact that the induction motor in combination with simple reversing rheostatic type control wants to run only at full speed. It pulls ahead towards full speed with more or less effort depending on the control, and cannot hold back until forced beyond full speed. This is not so bad when hoisting, because the load holds back and we can regulate the motor pull to attain reduced speed. For lowering, conditions are not so good for here both the motor and the load pull ahead and the motor cannot hold back until full speed has been exceeded. The big problem, therefore, lies in attaining control of the speed between zero and full speed when lowering. See Figure 1.

There are several schemes employed to attain reduced speed for lowering. If we limit our remarks to overhead traveling cranes there have been perhaps seven methods in use which produce various degrees of refinement in lowering speed control. The system, with which this paper is concerned, offers advanced refinement in low speed control and certain other new features.

An evaluation of the system can best be arrived at by comparison with those now in existence.

To the writer's mind, these seven systems naturally fall into two groups. In the first group the motor receives outside help from auxiliary rotating power machines, and in the second group the motor does all the work. See Figure 2. Our system would be included in the latter. See Figure 3.

The first group includes two examples; the mechanical and electrical load brake systems. In both of these the motor pulls up when running up, and either pulls down or not at all when running down. When lowering

**Figure 1 — Standard wound rotor motor performance is shown by curves.**

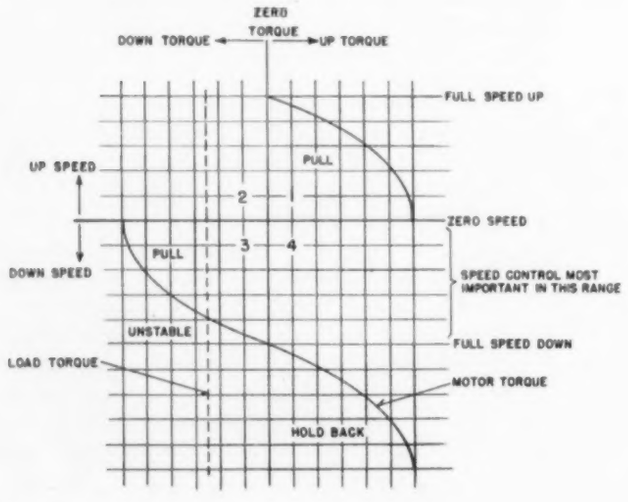
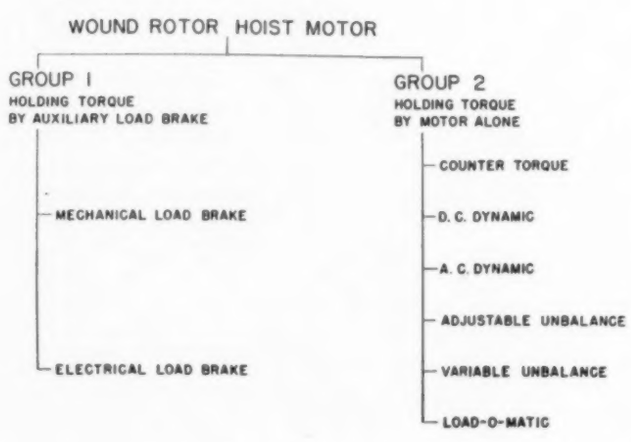



**Figure 2 — One method of classifying crane hoist control systems.**



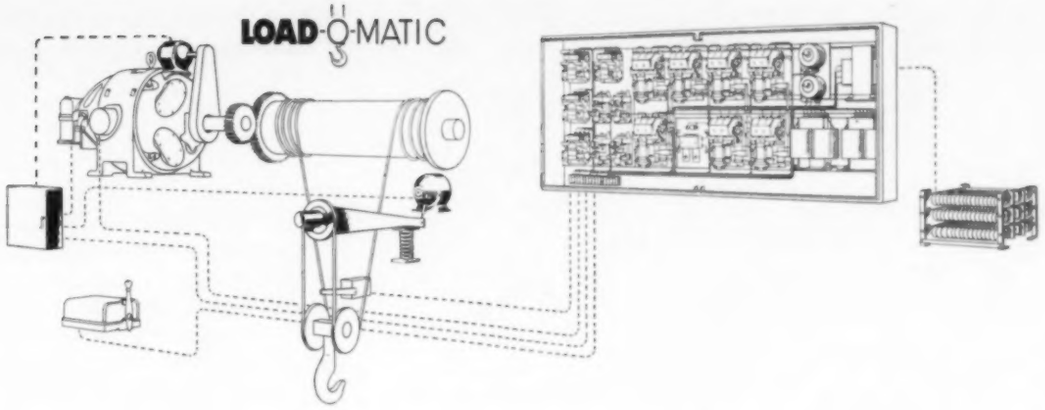



**Figure 3 — This system is regulated by load on hook.**

at less than full speed, all the retarding torque required to hold the load is supplied by the load brake alone. Since the brakes can deliver only retarding torque, they cannot run down of their own accord, and in addition to this the mechanical brake cannot be overhauled. They must, therefore, be driven in the down direction by the motor. The brakes accordingly have to absorb power from two sources, that is, the power being delivered by the descending load, as well as that being delivered by the motor. In other words, the brake must hold both the load and the motor. All of this energy must be absorbed by the brake and be radiated as heat. The ability of the brake to get rid of heat energy is the limiting factor in these types of drive.

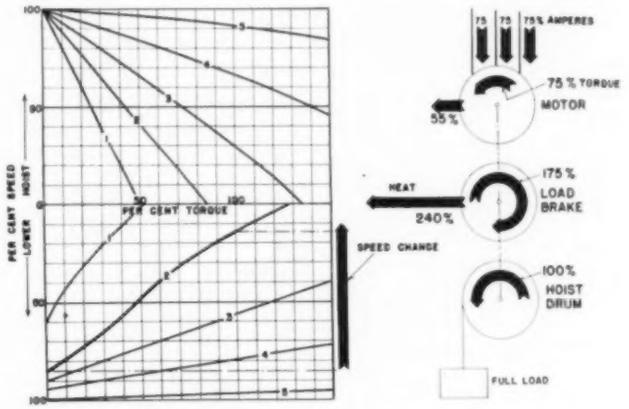



**Figure 4 — Mechanical load brake system performance curves and characteristics.**

*Mechanical load brake system* — The mechanical load brake develops retarding torque by mechanical friction and this is the only variable involved so far as holding the load is concerned during lowering (Figure 4). Speed does not have a direct association with the load other than that for a given controller point, the speed falls for increasing load. This characteristic of automatically reduced lowering speed with increasing load is highly desirable. It increases the accuracy with which the loads can be handled, and relieves the operator from increased responsibility and the machinery from unnecessary punishment. Similar performance has been incorporated into our new system.

*Electrical load brake system* — The electrical load brake develops retarding torque by eddy currents developed in the stator, and which might be considered as electrical friction. In this case, the lowering speed does have a direct association with load since eddy currents, which account for the holding torque, are a direct function of speed. See Figure 5.

The electrical load brake can be, and is made, effective

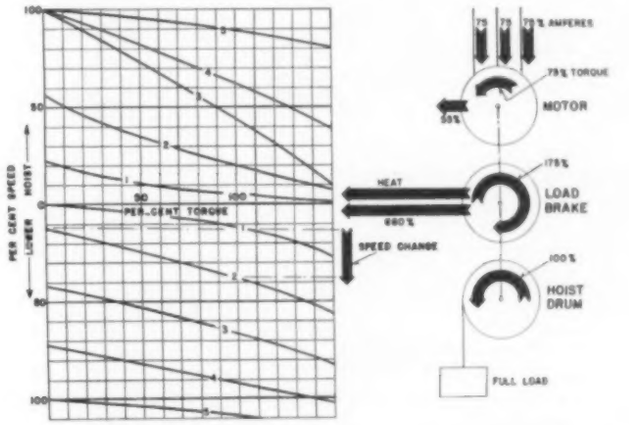



**Figure 5 — Electrical load brake system performance curves and characteristics.**

in the hoisting direction as well as the lowering. In this direction, the brake adds artificial load since the torque of the brake aids the load torque instead of opposing it. Since the brake torque is a function of speed, it does not prevent lifting heavy loads at low speed, but does prevent light hook speed from rising on the first and second controller points. This facilitates adjustment of slings preparatory to making a lift, with reduced hazard to personnel. This desirable performance characteristic has, to a large extent, been incorporated into our new system.

There are six examples in the second general class wherein the motor does all the work and where the tendency to run at full speed is eliminated; one of which uses simple rheostatic control, and the other five are all based on application of other than balanced three phase voltage to the motor primary. Among the latter are some which require rather high input current, and consequently are vulnerable from the motor heating standpoint.

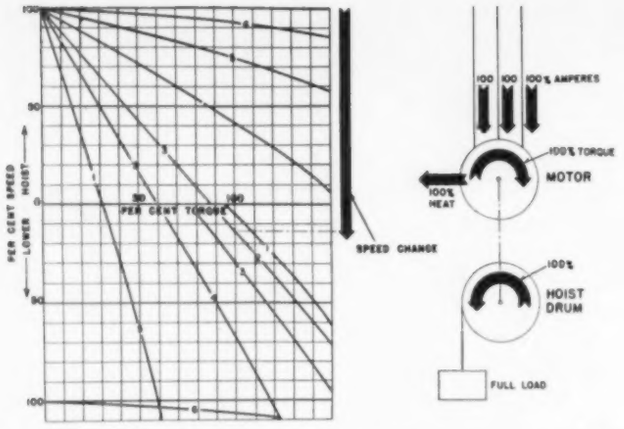



**Figure 6 — Counter-torque system performance curves and characteristics.**

*Counter-torque system* — This is the system which employs simple rheostatic control, and which incidentally has rather limited application. Here, the motor tries to run at full speed hoist, but is overhauled in the down direction by the load. See Figure 6. Note that a change from no load to full load causes a very large

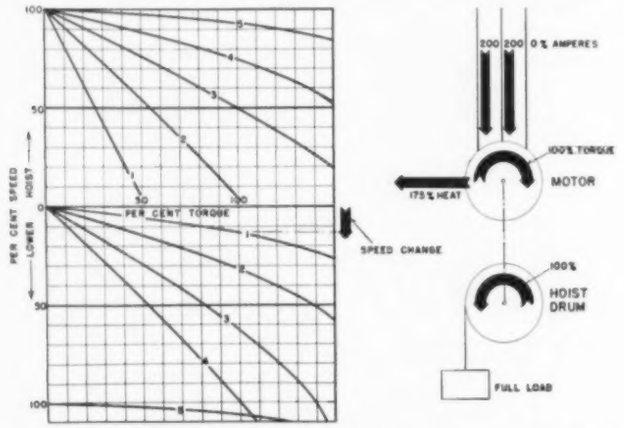



**Figure 7 — D-c dynamic system performance curves and characteristics.**

change in speed. The big fault with this system is the speed instability and this limits it to applications where the load does not change much and is heavy, as is the case for grab buckets. In favor of this system is the fact that the motor does all the work and does it with nominal input current and heating. When our new system handles heavy loads, the motor is caused to perform under circumstances very similar to those of the counter-torque system, and thus avoid abnormal motor heating generally associated with the second classification.

*D-c dynamic system* — The second of this group uses direct current for excitation of the motor primary, in conjunction with adjustment of the rotor resistance for lowering. In this case, the motor tries to remain at zero speed instead of running at full speed. No load produces no speed, but for the higher loads the motor is overhauled and develops holding torque by virtue of the overhauling, and a full range of speed selection is available. This performance is equivalent to dynamic braking. See Figure 7.

*A-c dynamic system* — The third of this group applies single phase to the motor primary windings with two terminals shorted, in conjunction with adjustment of secondary resistors. Like the d-c dynamic system, the motor tends to remain at zero speed and is overhauled with increase in load. The lowering speed cannot be adjusted below about 60 per cent normal, when the motor is developing 100 per cent torque during lowering. See Figure 8.

*Adjustable unbalance system* — The fourth of this group makes use of distorted or unbalanced three phase voltage to excite the motor in conjunction with an adjustment of secondary resistors. With this arrangement, the motor tries to run at some selected lowering speed less than 100 per cent depending on the degree of unbalance applied. In effect, a tug of war between a pulling and a retarding torque is going on inside the motor. Below a given speed the pulling torque predominates, and above this speed the retarding torque predominates, the difference appearing at the motor shaft. See Figure 9. All this requires high exciting currents and motor heating, and this is the limiting factor in this system. For some applications it is necessary to consider an oversize motor for this reason.

*Variable unbalance system* — We refer to this system as a variable unbalance voltage system, but from a

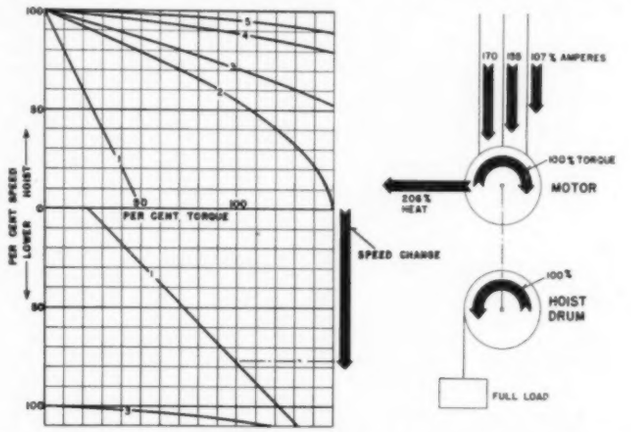
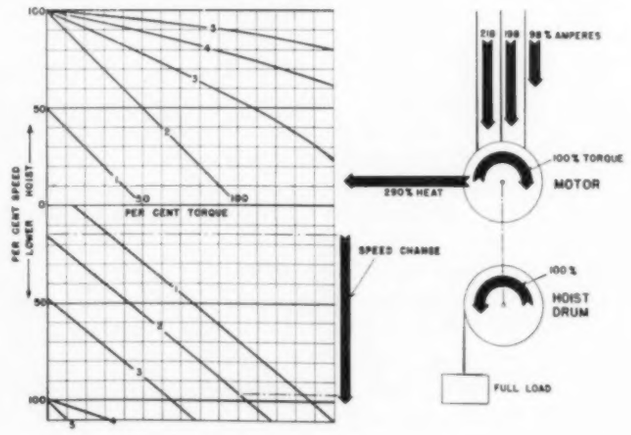



**Figure 8 — A-c dynamic system performance curves and characteristics.**

performance standpoint, it might be better to be called a variable counter-torque system (Figure 10). The motor pulls up while it is being overhauled in the down direction, same as it is in the counter-torque system, the

**Figure 9 — Adjustable unbalance system performance curves and characteristics.**



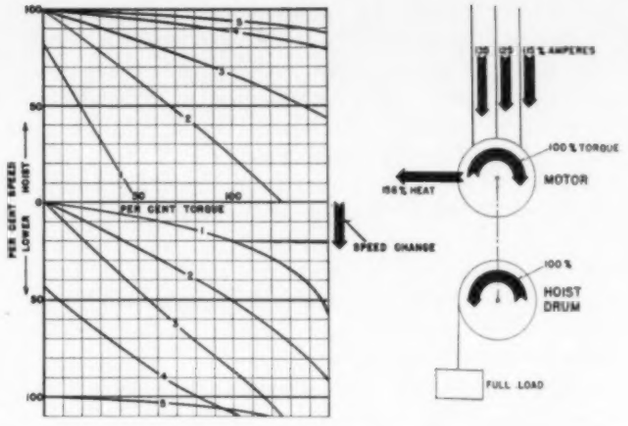



**Figure 10 — Variable unbalance system performance curves and characteristics.**

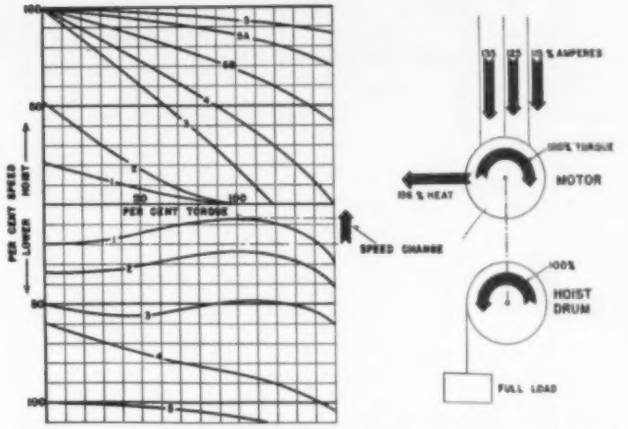



**Figure 11 — Load-o-matic system performance curves and characteristics.**

difference being that when zero speed is approached, the upward pull is killed off by automatic introduction of unbalance in the three phase voltage applied to the motor primary. At zero speed where three phase voltage is totally removed and there is no torque, conditions comparable to the adjustable unbalance system prevail. With the rise in speed associated with heavy load, the three phase voltage is restored to a large extent, and conditions comparable to straight counter-torque prevail — including the relatively low input current and motor heating.

*Load-o-matic* — This scheme is a development of the variable unbalance system, the difference being that most of the upward pull of the motor is in direct response to the weight on the crane hook. Speed accounts for only a small part of the total pull, and is dominated by the load effect. This situation permits the selection of any speed we see fit for a given load — within reason. See Figure 11.

The key item of this system is the load detector (Figure 12). This is a mechanism arranged to produce a mechanical deflection in proportion to the load on the hook, and an inductor operated by the same, to produce an electrical current in proportion to the load. The mechanism will be built in the rope system equalizer sheave, or bar, when there are 4-8-12-16-20 parts in the line. For reaving employing 6-10-14-18 parts, the equalizer is on the fall block, and when it is necessary to use this reaving, one of the top sheaves might be employed.

The system has been laid out to employ only components which are in general use, and of simplified nature and sturdy construction. In accordance with this policy, the inductor will be the widely used standard induction-repulsion motor except without the commutator or brush rigging. The rotor will never move more than 45 degrees and power will be brought out through flexible leads.

The mechanical modifications will vary depending on the crane design. On the majority of cranes, however the equalizer sheave is mounted on a shaft which in turn is rigidly supported by the trolley structure. Figure 12 indicates the modifications for such a crane. The moving part of the detector is a hub with extended lever arm. The equalizer sheave will be mounted on the large diameter on an anti-friction bearing. The hub itself will be supported on the shaft inserted in the offset bore also on an anti-friction bearing. As shown, the hub will tend to rotate clockwise due to the load force W acting through the lever arm B. This rotational effect is biased by a spring at C. The arm will have a throw of about 1 inch at the point where the inductor is coupled, and the rotation of the hub will usually not exceed some 2 or 3 degrees.

In addition to load intelligence supplied by the load detector, a limited speed intelligence is also required. This will be supplied by a pilot machine furnished integral with the motor and no modification of the hoist machine will be required.

Variable unbalanced voltage for application to the motor primary is obtained from what might be called a

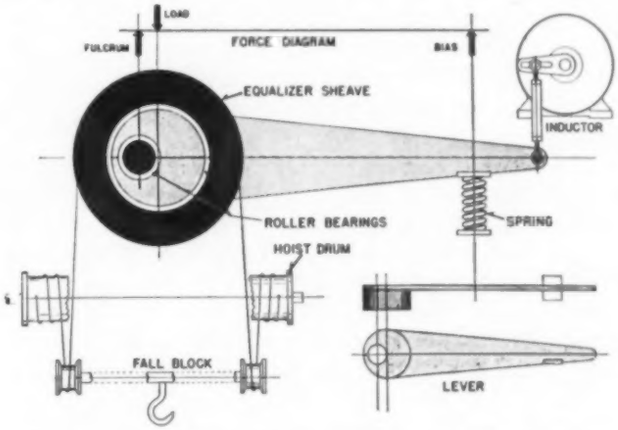



**Figure 12 — Load detector components and arrangement are shown in this sketch.**

"duplex inter-connected three phase" source. Figure 13 shows the conventional vectors of a three phase system in which the rotation is clockwise, L1 to L2 to L3. The primary and secondary of a transformer can be connected so as to set up a fourth phase L4, which in relation to L1 and L3 forms a three phase system with rotation also clockwise. A motor with terminals T1-T2-T3 connected to L1-L2-L3 respectively will have terminal voltage sequence T1-T3-T2. With the proper resistor in the secondary circuit, it will tend to run in the hoist direction and will deliver 125 per cent of normal torque at stall. If terminal T2 is removed from L2

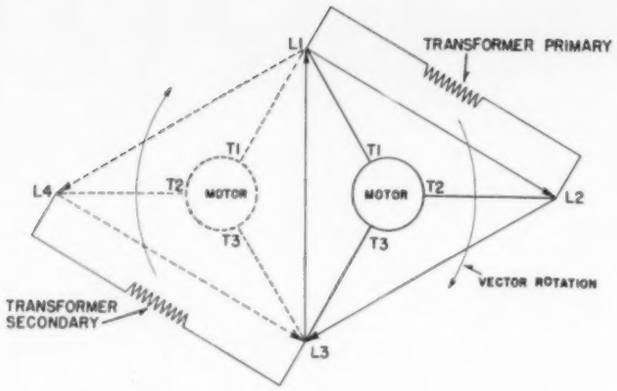



**Figure 13 — Phase shifter vectors for system in which rotation is clockwise.**

and connected to L4, the terminal voltage sequence will be reversed (T1-T2-T3) and the motor will therefore tend to run in the lowering direction and deliver 125 per cent normal torque at stall. In the variable unbalance and load-o-matic systems motor terminal T2 is not connected to either L2 or L4 when lowering or hoisting at reduced speed. It is connected between two saturable reactors which in turn are connected in series from L2 to L4. The impedance of L1 can be varied to cause T2 to take any vector position along the locus as shown in Figure 14. The transition from full torque clockwise (hoisting) to a specified torque counter-clockwise (lowering) is gradual. It can be explained mathematically that the rotating magnetic field of the motor becomes in effect elliptical with increase in unbalance, and the net torque becomes less. We attempt to illustrate this in Figure 15 where the area within the ellipses is indicative of the torque developed at various degrees of unbalance.

The position of T2 with respect to L2 and L4 for convenience can be expressed in terms of per cent unbalance per Figure 16. With no load on the hook, and with the motor at rest, the unbalance is always more than 100 per cent and might be 120 per cent as shown. Increase in lowering speed or addition of load to the hook or both will decrease the unbalance. This is accomplished by arranging speed and load electrical "signals" to increase the excitation, causing T2 to shift toward L2. As T2 recedes from L4 toward L2, the down torque being delivered by the motor decays to zero, then increases in the hoisting direction.

With no load on the hook, and the motor at rest with power applied, the unbalance will be 120 per cent and the motor lowering torque equal to T1. The motor will accelerate in the lowering direction accompanied by increase of excitation and decrease in unbalance. When the speed reaches D1, the unbalance has been reduced to 100 per cent and the torque is zero — hence, the motor accelerates no further. The main reactor excitation for this no load condition originates entirely in the pilot generator.

With 50 per cent load torque present and the motor at standstill, the load inductor will excite the main reactor to about 45 per cent normal. This reduces the unbalance to about 72 per cent and causes the motor to produce torque T3. T3 is less than T4 which is the torque the load is exerting on the motor shaft so the motor is overhauled and accelerates in the lowering direction. With increase in speed, the pilot machine adds exciting current to that already being produced by the load inductor, with consequent decrease in unbalance to 57 per cent corresponding to speed D2. At this speed the motor torque balances the load torque T4, and there is no further acceleration.

With full load torque present, the output of the load inductor raises the excitation to about 92 per cent and reduces the unbalance to about 24 per cent, where the motor can deliver torque T6. This is less than the torque T7 being exerted on the motor shaft by the load, hence the motor is overhauled to speed D3, where the motor torque balances T7, and acceleration halts.

A curve drawing through D1, D2, D3 is the lowering speed-load locus characteristic such as would apply to the first controller point.

For the second controller point, the field winding of the pilot machine will be weakened such that the speed must rise higher to D4, D5 and D6 to produce the stabilizing excitation. The second locus will be of the same general slope as the first, since the pilot machine "speed signal" is about equally effective at all loads.

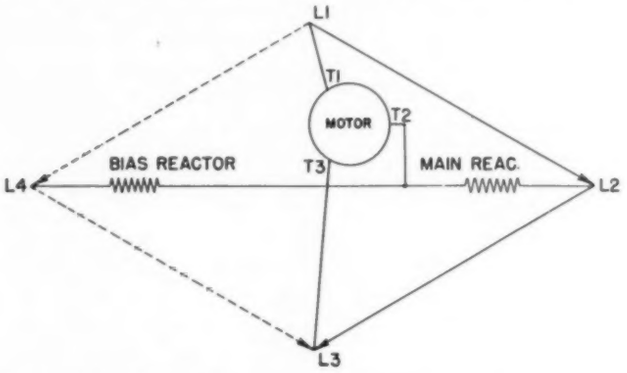
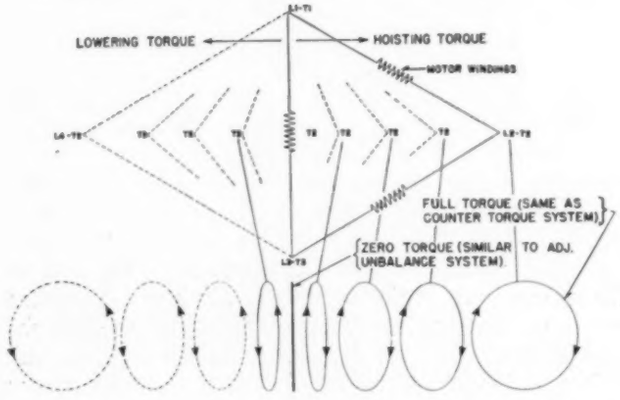



**Figure 14 — Phase shifter reactors are shown for reversing without contactors.**

For the third and fourth points, resistance is inserted in series with the main reactor excitation circuit so that both the output of the pilot machine and the load inductor are weakened. The weakened "load signal" has the effect of causing T3 and T6 to recede from T4 and T7 respectively, to the new positions T3, T4, or T3, "T4" so that for the higher loads the speed signal must be proportionately greater, and hence the speed higher.

**Figure 15 — Control of torque magnitude and direction by voltage unbalance. Enclosed areas are indicative of torque developed with motor at standstill.**


LOWERING TORQUE
HOISTING TORQUE
MOTOR WINDINGS
FULL TORQUE (SAME AS COUNTER TORQUE SYSTEM)
ZERO TORQUE (SIMILAR TO ADJ. UNBALANCE SYSTEM)

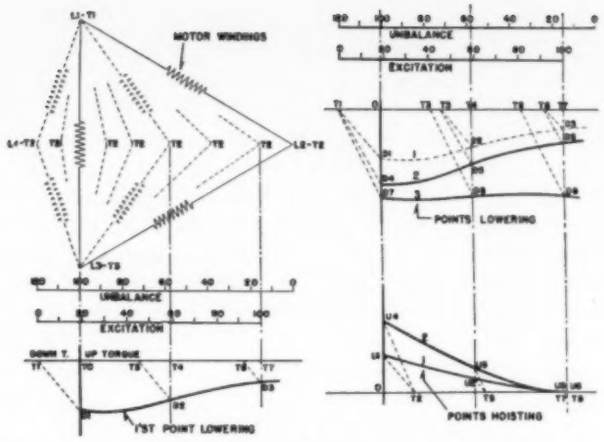



**Figure 16 — Determination of speed-torque locus by combination of speed and load excitation.**

With no load on the hook and the controller moved to the first point hoist, the main reactor is excited to reduce unbalance to about 85 per cent, where the motor produces hoisting torque and is unopposed by any load. The motor accelerates in the hoisting direction and the pilot machine now generates a voltage in opposition to that of the master switch excitation, since the rotation has been reversed. With increase in speed, excitation decreases, unbalance increases and reaches 100 per cent with the speed at U1 where the accelerating torque disappears.

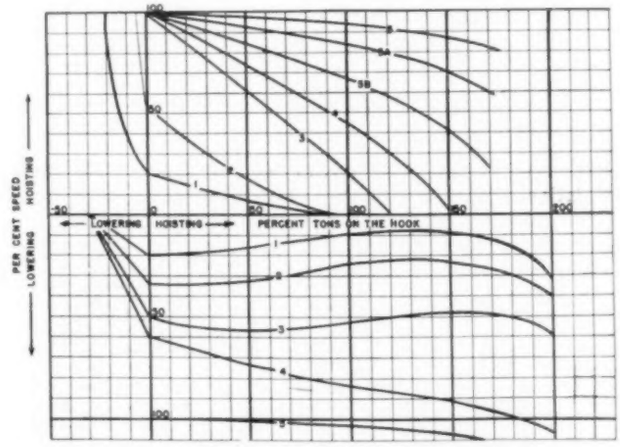



**Figure 17 — Typical performance with effect of crane friction added. Crane efficiency is 80 per cent.**

With 50 per cent load torque present on the hook, the load inductor excitation in addition to that produced by the master switch reduces the unbalance so as to produce motor torque T5. This is greater than T4 which is the torque being exerted on the shaft by the load, hence the motor accelerates to speed U2 where the motor torque has fallen off to balance T4.

For 100 per cent load, T8 will equal or slightly exceed T7 such that the motor may not be able to accelerate the load in the hoisting direction, but cannot be overhauled in the lowering direction. The speed will be low, or zero.

A curve drawn through U1, U2, U3 is the speed-load first controller point hoisting locus. For the second control point, the field winding of the pilot machine is weakened so that the speed must rise higher to U4 and U5 to balance the load and motor torques.

Figure 17 shows estimated curves applying to a crane having an efficiency of about 80 per cent and which shows rope speed versus tons on the hook. It is to be understood that these curves do not represent the ultimate in torque values that can be attained. The torques shown are limited by the control to values which are practical from a current input standpoint, and for crane hoist applications. With other control components the torque delivered can approximately equal the maximum that can be delivered by the motor. The curves in Figure 18 are test results taken with a dynamometer

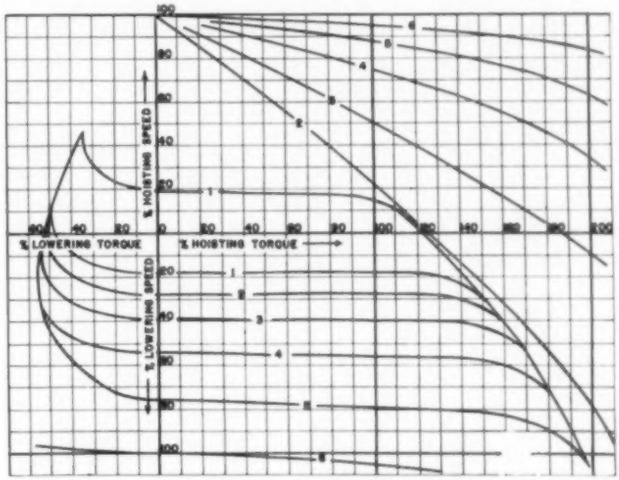
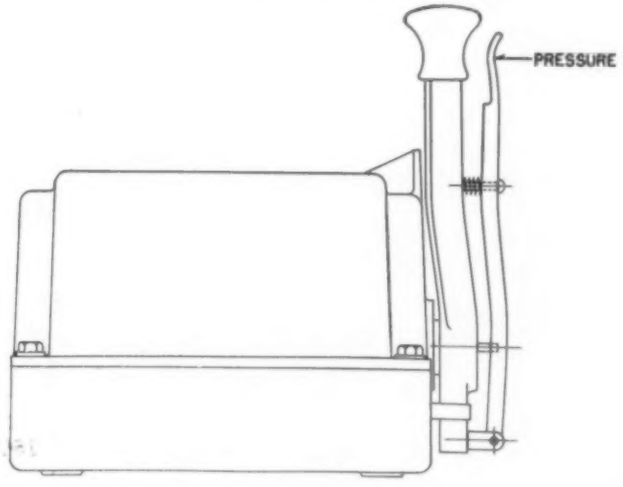



**Figure 18 — Variable unbalance dynamometer test curves are shown with regulated speed excitation only.**

and show results when the variable unbalance system is excited with regulated speed excitation. For the particular set up, curve 2 hoisting represents the maximum torque that can be delivered by the motor due to limiting secondary resistance. Note how closely the regulated curves (1 hoisting, 2 to 5 lowering) approach this characteristic. Similar performance can be attained with curves 3 or 4 hoisting, serving as the limit, however, the duty would have to be highly intermittent due to increased motor input.

**Figure 19 — Vernier speed control may be obtained by pressure switch — master switch adaptation.**



The presence of the load detector and the pilot machine makes it possible to provide features not usually available on a-c cranes, and some of which are possible only with the load-o-matic.

1. Extreme slow speed maneuvering well beyond ordinary requirement for occasional operations.

This type of performance is made available by an auxiliary squeeze lever on the master switch handle as shown in Figure 19. Application of pressure has the effect of slowing down the lowering motion or speeding up the hoisting, and the effect is in proportion to the pressure applied. Thus, the first point lowering speed for any load can be reduced to any low value down to and including zero, or "load floating." The results of this performance are rather startling and can only be fully appreciated by personal operation of the controls. No other system except perhaps d-c adjustable voltage has any possibility of such a refinement.

2. It is desired that the operator be warned when the hook is carrying more than the crane rating.

The mechanical part of the load detector deflects in proportion to load. A limit switch may be operated by the deflection corresponding to crane rating and arranged to operate a visual or audio signal.

3. It is desired that the crane lifting ability be definitely limited to a certain tonnage.

This can be accomplished by a contact on the load detector similar to the arrangement mentioned above for the signal. The cutoff is instantaneous and direct acting, and occurs before, not after, the crane has been subjected to dangerous strains.

4. Hoist limit switch fails to function to stop upward movement of the hook.

When the cable tightens due to jamming of blocks, the load detector arm is depressed as would be the case with excessive load. This would operate the overload cutoff to stop the hoist. The detector in this situation serves as a backup for the hoist limit switch.

5. It is desired that dynamic braking be applied in case of power failure or other emergency tripping.

This can be accomplished by increasing the tachometer size such that it may have an intermittent rating of perhaps 3 to 5 per cent of that of the hoist motor. The armature will be connected across two motor terminals through a series field and blocking rectox. If the hoist is lowering at the time of emergency, the d-c machine builds up as a series generator to excite the motor primary for ordinary d-c dynamic braking. If the motion is hoisting when the emergency occurs, the rectox prevents de-magnetization of the d-c machine while the motion continues, and assures build up when the motion reverses due to overhaul.

6. Master switch is centered, but magnetic brakes fail to hold the load.

When the electric braking is removed, shortly after the switch has been centered, the dynamic braking circuit is set up and will prevent overspeeding.

7. Tachometer fails to function.

The speed will merely rise higher than ordinary. If there is light or no load on the hook, the speed may eventually reach synchronism. For heavy loads the rise will vary depending on conditions, but with the controller on the first or second point, should be less than synchronism, and less than the allowable limit of 150 per cent for the third and fourth points.

8. Inductor fails to function.

This item originates most of the excitation. Any system such as this one, the electric load brake, and d-c adjustable voltage hoists should include protection against loss of the same. This system includes a series current type relay which opens a contact upon loss of excitation to cut off power, sets holding brakes and applies dynamic braking. This is effective only for loads heavy enough to cause overspeeding. For the lighter loads where the excitation is too low to actuate the relay, its contact is bypassed by a light load contact on the load detector.

## DIRECT CURRENT

By G. E. MATHIAS
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Westinghouse Electric Corp.
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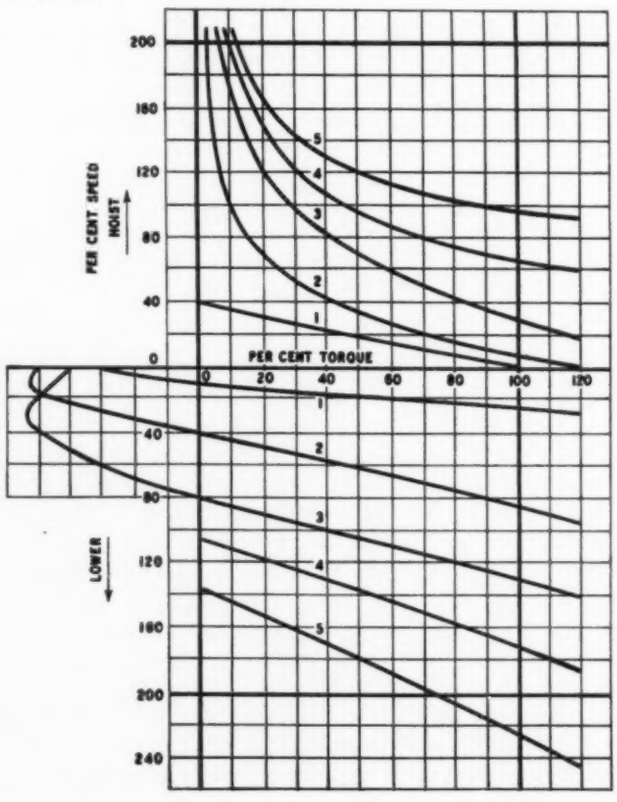
▲ D-C dynamic braking hoist control has long been a favorite where hard service is encountered. The fundamental control scheme is unchanged from that originally used about 1908, but that does not mean that improvements have not been made nor that they will not continue to be made. An examination of the reason for this popularity would probably reveal the following facts:

1. *Basic simplicity* — A standard series wound motor is controlled by means of a resistance controller.
2. *Suitable speed-torque characteristics* (*Figure* **1**) — Possibly not the theoretical ideal, but with enough

**Figure 1 — Constant potential d-c crane hoist characteristics.**



desirable features that they are regularly used as the standard of comparison for performance of the other types of hoist control.

3. *Standard electrical components* — Mill rated contactors, heavy duty resistors, and a series wound d-c motor, usually of the AISE standardized type comprises the bulk of the electrical equipment. No delicate or fragile devices are required.
4. *Rugged dependability* — Heavy duty mill type electrical equipment minimizes unscheduled downtime. Equipment and system simplicity reduces normal maintenance time.

The motor is operated as a series motor in hoisting, since the inherent characteristics of a series motor automatically provides high speeds when hoisting light loads and slow speeds when hoisting heavy loads. In the lowering direction where overhauling loads are encountered, the motor functions as a shunt machine by connecting the series field across the line in series with resistors. Light hooks are driven down and overhauling loads are retarded by dynamic and regenerative braking.

It is generally agreed that crane hoist duty is severe on contactors. A new line of heavy duty contactors is now available, developed by us especially for mill service (Figure 2). A short tabulation of some of the special features of the contactors are:

1. *Unit construction* — The contactor is assembled as a complete unit including the interlocks. Accurate alignment of all parts is insured and is not dependent upon control panel drilling.
2. *Knife edge bearing* — The armature bearing is a true knife edge bearing of hardened steel. There is a coil spring that positively holds it in place so that it is not affected by vibration or tilting.
3. *Unit interlocks* — All stationary and moving contact parts are assembled on one base. The entire unit is mounted on the contactor by two machine screws which are easily accessible to a screwdriver from the front of the contactor. Correct alignment to secure proper operation of the interlock is assured.
4. *Quick quench arc box* — This arc box plays an important part in long contactor life. Careful magnetic circuit design, scientific chamber construction, and the selection of the finest materials known for being impervious to arcing makes it possible to prevent much contact burning and arc box deterioration even on heavy overloads.
5. *Contactor servicing simplified* — The stationary and moving contacts are wider and thicker than on previous designs and are interchangeable. They are easily removed from the front with a wrench and their alignment is definitely established by a deep tongue and groove. The entire contactor can be disassembled in a few seconds from the front using ordinary electrician's tools or may be removed from the panel entirely by disconnecting the electrical leads and loosening the mounting bolt. Contactor alignment will not be jeopardized. Tests and actual performance under adverse conditions have shown that knife edge bearing, noncarbonizing glass insulation on the blowout coil, and the quick quench arc box extend contactor life and reduce maintenance.

A good d-c dynamic braking crane hoist control must have trouble free resistors as well as rugged contactors. Some of the qualities that make a resistor ideal for crane duty are:

1. Light weight.
2. Compactness.
3. Shock and vibration proof.
4. Low temperature coefficient of resistance.
5. Stability of element material so that it does not flake or deteriorate due to elevated temperature cycles.

The type WM, edgewound resistors, (Figure 3), possess these qualities. They are light in weight, nonbreakable, and have a high thermal efficiency making compact resistor assemblies possible. The tubes are individually removable from a frame and are made of a stainless steel strap, wound edgewise on a refractory core which is reinforced by a longitudinal supporting bar. The end terminals are welded to the strap and are supported by the tie rod.

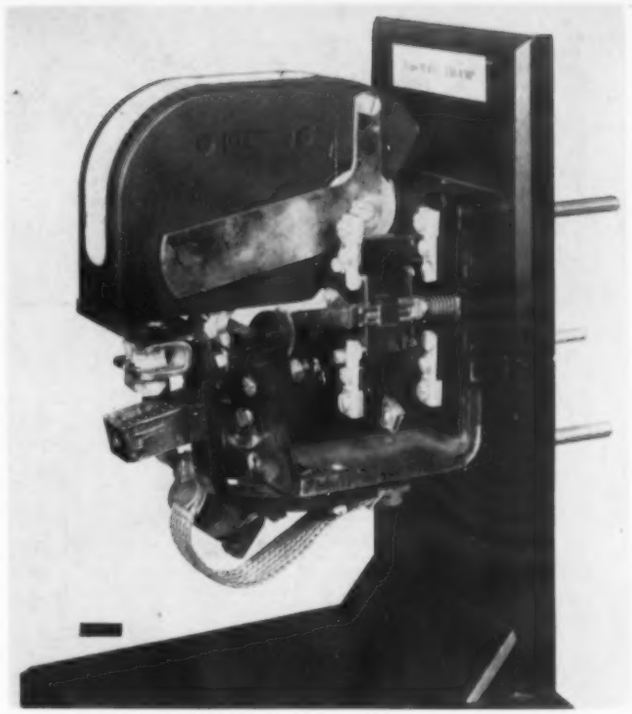
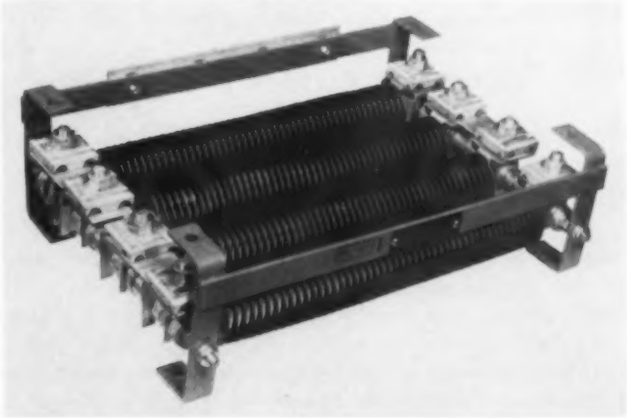


**Figure 2 — This single-pole, magnet closed d-c contactor has an eight-hour rating of 150 amperes.**

**Figure 3 — Unit frame type edgewound resistors make compact resistor assemblies.**



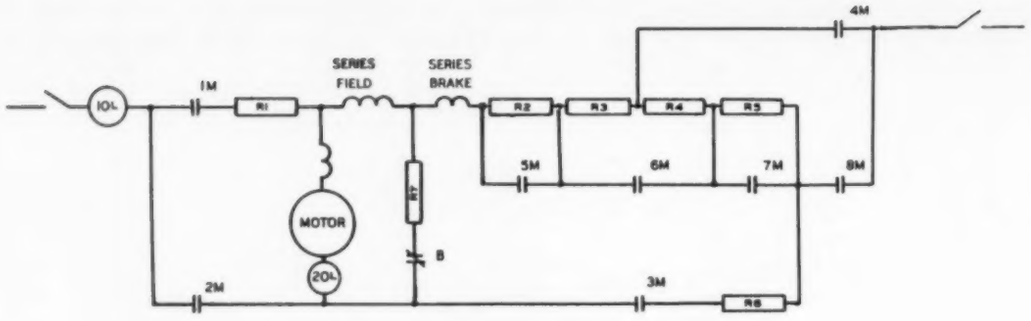



Figure 4 — Main circuit schematic diagram of d-c constant potential crane hoist control.

| DEVICE | LOWER | | | | | OFF | HOIST | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 | | 1 | 2 | 3 | 4 | 5 |
| 1M | X | X | X | X | | | X | | | | |
| 2M | | | | | | | X | X | X | X | X |
| 3M | X | X | X | X | X | | | | | | |
| 4M | | | X | X | X | | X | X | X | X | X |
| 5M | | | | | X | X | X | X | X | X | X |
| 6M | | | | X | X | | | | | X | X |
| 7M | | X | X | X | X | | | | | | X |
| 8M | X | X | X | X | X | | | | | | X |
| B | | | | | | X | X | X | | | |

X INDICATES DEVICE CONTACTS CLOSED

Parallel to the development of the new line of contactors, a study was made to devise an improved crane hoist control scheme. Actual tests and operation on the test tower were used to check calculations. From this study the hoist control scheme shown in Figure 4 was evolved.

Some of its salient features are:

1. *Simplicity* — Nine contactors are required, one being spring closed.
2. *Smooth operation* — This is due to proper proportioning of speed increments between master switch points and proper selection of resistor connections.
3. *Accurate inching and spotting* — Slow speed hoisting is available even with empty hook. Suitable kick-off torque is obtained with careful resistor design enabling the motor to reach steady state speed quickly without overshoot.
4. *Lowering speed as high as is consistent with safety* — Also, an independent adjustment is available for the high speed lowering point.
5. *Reduced maintenance* — New heavy duty contactors combined with a control scheme and resistor design that prevents excessive current peaks during transitions or while plugging aids materially in prolonging equipment life.

## D-C ADJUSTABLE VOLTAGE HOIST CONTROL

The use of constant potential d-c drives is universally accepted and broad in scope. As operating requirements for any particular application become more critical, it is found that adjustable voltage d-c drives are often capable of satisfying the new conditions. In the realm of material handling, the adjustable voltage drive has not reached the prominence that it enjoys in many other fields. However, within the past few years several such drives have been installed on gantry cranes, ore bridges, and unloading towers. Recently a new type adjustable voltage hoist control was developed which rivals the constant potential in simplicity, yet has the inherent advantages of an adjustable voltage system. Even so, it is not anticipated that this drive will replace the standard dynamic braking hoist control, but rather supplement it for certain applications.

An investigation of the speed-torque curves reveals several items of interest (Figure 5).

1. Heavy loads are automatically lowered safely at a rate reduced from that possible with light loads.
2. High light-hook speeds are available in either direction.
3. The first point, hoist or lower, gives flat, slow speed operation for accurate positioning of hook or load.
4. The speed-torque curves are uniform in shape and evenly distributed providing the operator with full smooth control of the hoist at all times.

## CHARACTERISTICS OF ELECTRICAL EQUIPMENT

From the schematic diagram, Figure 6, it is noted that a compound wound generator supplies power to a compound wound motor. During hoisting, the generator polarity is such that terminal "A" is positive. Current flows from this terminal through the differential series field of the generator, a blocking rectifier, the motor series field and armature, and an overload relay back to the generator. Resistor, "R" shunts part of the current from the generator and motor series fields. These elements are proportioned with the shunt fields to obtain the steep speed-load characteristic necessary for fast handling of an empty hook.

For power lowering with no overhauling load, the generator polarity is reversed by reversing its shunt field and current flows from generator terminal "B" through the overload relay, the motor armature, and the resistor, "R." Current is blocked from flowing

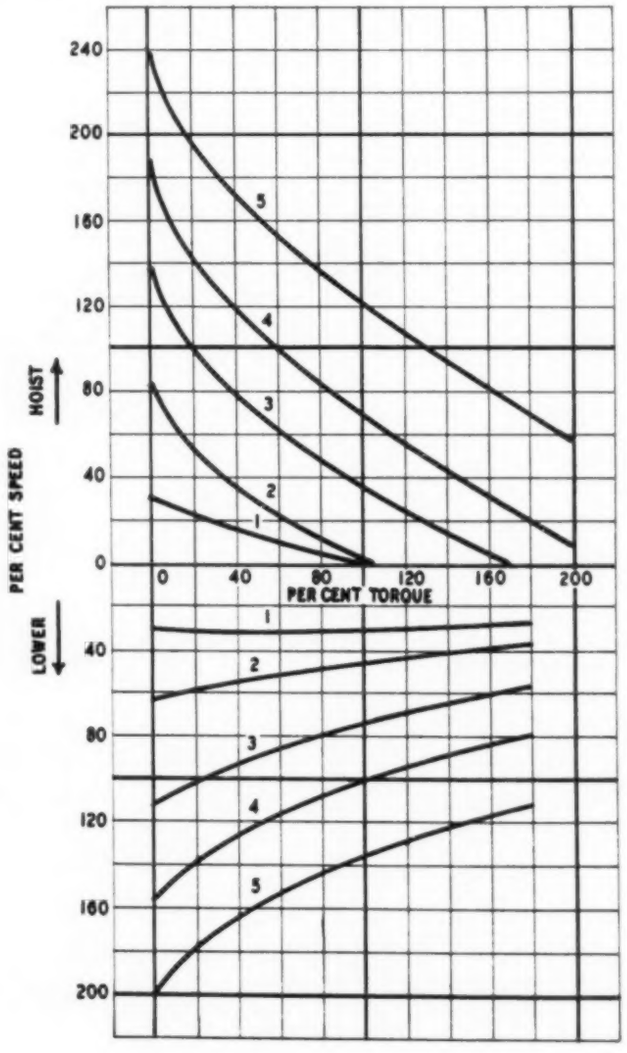
through the series fields by the rectifier. Also, the generator differential field is short-circuited by contactor "GF." During this condition the generator and motor both function as shunt machines. Positive motor torque, amounting to about 50 per cent of motor rating, is thereby insured in the lowering direction. This would not be possible if the current could flow through the series field in the reverse direction reducing the motor flux.

When lowering an overhauling load, the motor has a tendency to increase its speed and its counter-electromotive force will become greater than the generator voltage. The current in the main loop, therefore, reverses and flows from terminal "D" of the motor through the overload relay, the generator armature, and the motor series field. The generator differential field is still short-circuited.

A large load will cause a high regenerative current which in turn increases the motor flux and voltage. For a given generator voltage, as determined by the position of the master switch, the motor will run at a lower speed to match this voltage than it would with a light load and less flux.

The extent of automatically reducing the overhauling speed as a function of load is limited by the stability of

**Figure 5 — Speed-torque characteristics are shown for adjustable voltage d-c crane hoist.**



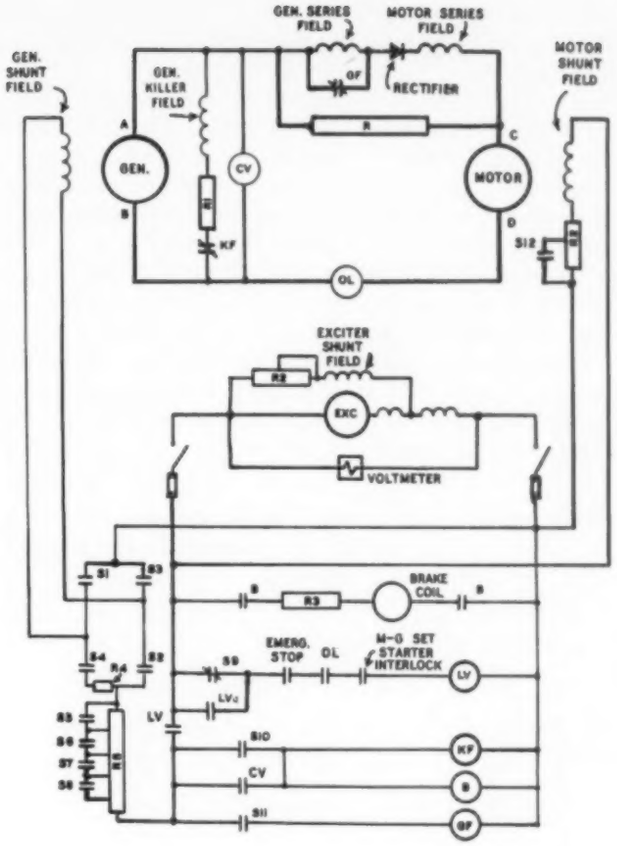




**Figure 6 — Adjustable voltage d-c crane hoist control schematic diagram.**

the system. Basically such a relationship is unstable. However, it can be made to operate successfully if the motor speed can change promptly and follow the motor flux readily, i.e., the mechanical time constant of the hoist must be appreciably shorter than the electrical time constant of the motor field.

Judicious co-ordination of time delays in the various fields coupled with the inherent characteristics of the generator and motor result in a smoothness of operation that is highly desirable. The generator differential series field is sufficiently strong to keep transient current peaks below 200 per cent even under the most adverse operating conditions regardless of how carelessly the master switch may be maintained.

The dynamic braking and killer field circuit functions in a very effective manner. Closing contactor "KF" energizes this strong differential shunt field and decreases the induced generator voltage to near zero. The remaining voltage drop across the generator terminals is due to the IR drop of the circulating current generated by the overhauling motor. Heating in the dynamic braking resistor and killer field circuit becomes negligible at this low voltage, making it possible to insure this important protection with a small, compact resistor.

## HOIST PERFORMANCE

Rapid acceleration for both hoisting and lowering has not been sacrificed even though light hook speeds are high. This is possible because the generator voltage is

permitted to increase to about 140 per cent at no-load thereby allowing a higher motor flux and torque for a given speed.

The stored kinetic energy in the motor must be removed each time the hoist is stopped. On many hoists the brake must absorb most of this energy and dissipate it as heat. Applications utilizing series or compound wound motors often fall into this category because there is little or no regeneration. The reverse currents in the series field kills the motor flux and therefore no braking torque is produced, even though a large circulating current is present.

With the new adjustable voltage scheme a blocking rectifier prevents the circulation of regenerative current through the motor series field if the current is in the direction to decrease the motor flux. The shunt field

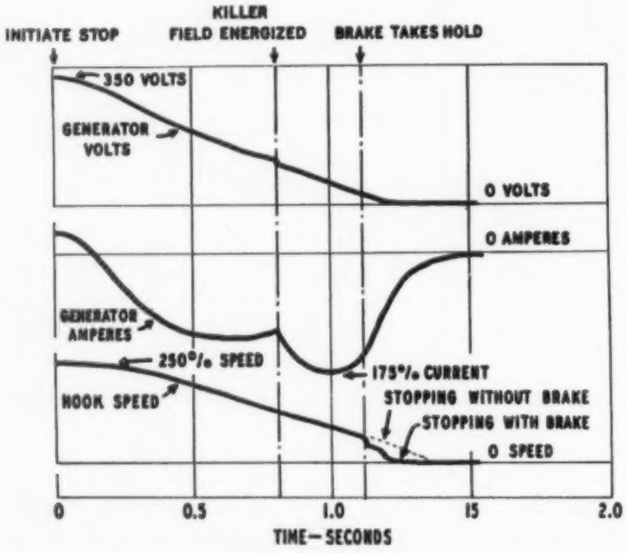



**Figure 7 — Test oscillogram of adjustable voltage control stopping light hook from hoisting at 250 per cent rated speed.**

can maintain a substantial flux which in conjunction with the regenerative current in the main circuit will insure braking torque that will retard the hoist.

The combination dynamic braking and killer field circuit also assists in reducing the hoist's speed, but does not become effective until the generator voltage has dropped to about 40 per cent of its maximum value.

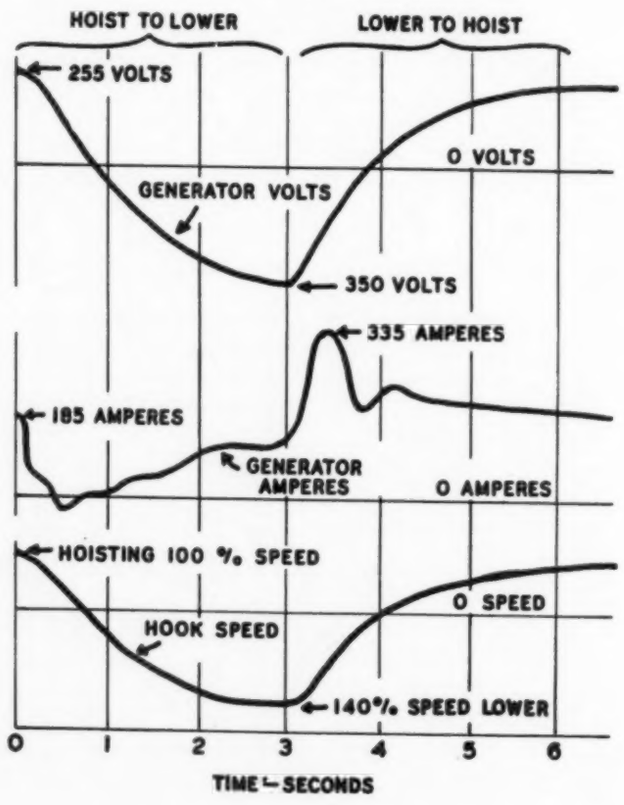
The brake receives very little wear as is shown in the oscillogram of Figure 7. It is adjusted to set at about 25 per cent of the maximum speed at which time the kinetic energy has diminished to only 6 per cent of its original value. Brake duty is reduced to primarily that of holding the load which assures lower brake maintenance and greater reliability in case of an actual emergency.

Smoothness of performance is further illustrated by the oscillogram in Figure 8. The motor is hoisting full load at rated speed when the master switch is immediately thrown to the full speed lowering position. It is then plugged from full speed lowering by instantly returning the master switch to the fifth-point hoist. This test condition is more rigorous than would be expected in normal service, yet the operation is refined. There is no indication of excessive stress, electrical or mechanical, in any of the units in the entire system. An analysis of various tests at rated load shows the additional stress caused by acceleration and deceleration forces is not greater than 25 per cent of full load.

The failure of any component should not jeopardize the safety of the operator or equipment. For purpose of demonstration the brake may be blocked open, simulating failure. Bringing the master switch to the off position automatically applies the killer field and dynamic braking resistor retarding the hoist regeneratively to a stop as shown in Figure 7, or allowing it to drift at a slow controlled rate if the hoist is loaded.

Hoists today have relatively high overall mechanical efficiencies. Failure of any one item of equipment, or even a combination of items though not generally anticipated should be taken into consideration in the design of the control equipment. For example, unless suitable precautions are taken, a failure of primary power to the motor-generator set could easily result in dangerous overspeeding of the set, especially if a heavy load were being lowered. However, a contact on the motor-generator set starter opens the hoist safety circuit initiating an emergency stop if the incoming power fails. The killer field and dynamic braking circuit becomes effective reducing the generator voltage, and brake sets. The stored kinetic energy of the hoist motor is absorbed by the combination dynamic braking and killer field circuit and also thermally in the generator armature. Very little is able to return regeneratively to the motor-generator set because the killer field has reduced the generator flux to near zero. Without flux,

**Figure 8 — Adjustable voltage hoist oscillogram plugging 50-hp, 180-amp, 230-v motor from both hoisting and lowering at maximum speed with rated load.**



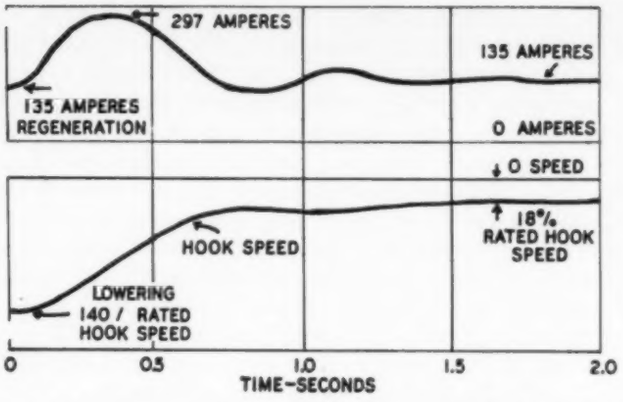



**Figure 9 — Oscillogram of adjustable voltage hoist control test of 50-hp, 230-v, 180-amp motor lowering full load at maximum speed at time power failure is imposed.**

torque cannot be developed even though current may be circulating through the armature.

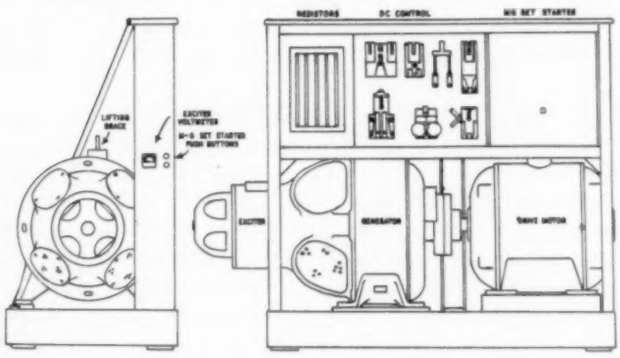
Figure 9 is an oscillogram which depicts this action a little more in detail. It was taken while lowering full load and, for good measure the brake is blocked open and the shunt field of the motor also disconnected. A simultaneous combination of all these failures; primary power, brake, and motor shunt field is certainly an extreme case, and while not likely to occur, does clearly demonstrate the inate safety of the system. Within ¾ of one second after the power failure is initiated, the speed of the load had been reduced to 18 per cent. The load continues to drift down at this slow rate. The motor-generator set does not receive pumped back energy, therefore, coasts to rest.

## CONSTRUCTION

Compactness of design is achieved by placing the control panel, resistors, and motor-generator set starter directly above the motor-generator set (Figure 10). The entire unit is completely assembled and factory wired. Crane wiring is reduced to the connection of master switch leads and motor leads.

One suitable location for the motor-generator set is the bridge runway. Its total height including the control is usually less than a comparable d-c dynamic braking control panel.

**Figure 10 — Motor-generator set and control panel assembly for 50-hp adjustable voltage hoist control. Total height is 54½ in., length 72 in., width 30 in., weight 3600 lb.**



## CONCLUSIONS

The new adjustable voltage hoist control is another step forward in the refinement of the operation of material handling. Some of the prominent characteristics of the new adjustable voltage hoist control can be summarized as follows:

1. Superior performance is obtained both in ranges of speeds available and smoothness of control.
2. Maximum safety to personnel and equipment is insured in case of power failure or brake failure by the ability of the hoist control to automatically lower the load at a safe rate.
3. Installation time, expense, and space requirements are minimized because the motor-generator set and control panel are assembled with internal wiring at the factory.
4. Adjustments for no-load and full load speeds are independent and are easily made.
5. Maintenance is simplified by the accessibility of all apparatus. Also, the amount of apparatus has been reduced to a very minimum by designing the desirable inherent characteristics into the motor and generator.
6. Simplicity is achieved. No special rotating or static regulators of any type are required. Other than the knife switch, the control apparatus consists of four contactors and two relays, one of which is an overload relay.

# DISCUSSION

**PRESENTED BY**

**F. M. BLUM, Manager, Crane Sales Division, Harnischfeger Corp., Milwaukee, Wisc.**

**W. R. WICKERHAM, Control Engineering Department, Westinghouse Electric Corp., Buffalo, N. Y.**

**C. G. DIMITT, Supervisor Design Engineering (Electrical) South Works, United States Steel Co., Chicago, Ill.**

**J. A. CORTELLI, Chief Engineer, Clark Controller Co., Cleveland, Ohio.**

**A. H. MYLES, Assistant Chief Engineer, The Electric Controller & Mfg. Co., Cleveland, Ohio.**

**S. RIFKIN, Industrial Engineering Department, General Electric Co., Schenectady, N. Y.**

**F. M. Blum:** The load-o-matic control provides speed control curves which are most desirable under Mr. Wickerham's so-called Group 2 type of control. The slope of the lowering curve approaches that of conventional d-c dynamic lowering control which, from a designer's point of view, is the standard of comparison. As Mr. Wickerham so ably pointed out, crane builders have been confronted with the troubles encountered with a mechanical load brake on all a-c operated cranes. They also had for comparison the trouble free d-c dynamic braking control which eliminated the mechanical load brake for some 40 years. Many a-c control schemes were devised to eliminate the mechanical load brake, most of which fall into Group 2.

In our opinion, the load-o-matic control lacks simplicity. It involves special application to the crane structure in the form of applying the load detector. Since the crane builder must apply the load detector, some objection to applying this control can be looked for from this source. The complicated control circuit, together with the synchronization of load detector, speed detector, and other allied apparatus would undoubtedly require the services of a competent control engineer for initial field installation and adjustment. We believe the lack of simplicity would receive objectional comments from the average maintenance electrician. The initial cost of this control in comparison to other schemes has not been mentioned.

Even though we have raised some questions in regard to the application of this control to overhead traveling cranes, I have seen a demonstration of this control and its speed regulation, and must admit it is a very unique approach to the a-c control problem.

**W. R. Wickerham:** It perhaps can be said that all high performance hoists employ either an auxiliary rotating machine of some sort, or rectifiers of one kind or another, or both, with associated resistors and transformers. Thus, in the mechanical or electrical load brake systems, the brake itself is a rotating machine, rectifiers are necessary for excitation of the electrical load brake, and one version of the latter system employs an auxiliary d-c machine. The d-c braking system employs in its simplest form a rather large rectifier, one variation employs an auxiliary a-c machine, another a separate motor-generator set. In comparison the load-o-matic would seem to be somewhat of a stand off, since it also employs rectifiers, an auxiliary d-c machine and the "load detector," the electrical part of which is really nothing more than a transformer with a movable secondary winding.

The control is designed to limit the field adjustments at installation to three; one mechanical and two electrical. All adjustments will be of the "cut and try" type. With full load on the hook, the throw of the load inductor will be set mechanically to produce any desired lowering speed. With no load on the hook, the first point hoisting and lowering speed will be set by adjustment of a slider type resistor unit.

**C. G. Dimitt:** Mr. Wickerham has presented an interesting development in a-c crane control. We note that the author states that the characteristic curves have been based on actual performance data. We would like to ask the author to list some of the types of service for which crane controllers of the new type have been provided, and the operating districts where they have been installed.

**W. R. Wickerham:** We have operated a load-o-matic crane over one of our test and assembly floors for heavy machinery at the Buffalo works for about two years. As of the present, equipments are being manufactured for machine shop, plate shop, shipyard, hot ladle and general purpose applications.

**J. A. Cortelli:** Mr. Wickerham and Mr. Mathias today have presented to us a review of the efforts of the control engineer to arrive at an easy solution in the design of an a-c hoist controller which would be simple and would have desirable operating characteristics. The problem has not been so much one of designing a hoist control system which would give the desirable characteristics, but has been one of accomplishing this without adding too much or any accessory equipment to the hoist other than that normally associated with a hoist. That is the a-c motor and a brake. The efforts have been toward the possible elimination of the mechanical load brake or other loading devices usually required to be used in conjunction with the a-c motor in order to obtain desirable speed/load characteristics. Most of this problem has revolved around the speed load characteristics in lowering, for those in hoisting are, or can be, very close to those usually associated with d-c hoists using series motors.

In review of the systems already in existence or tried, I believe that the d-c dynamic lowering system as applied to a-c motors has been neglected or not explored sufficiently to take full advantage of the possibilities with such a system.

We have, in the last few years, done considerable work with such a system and have put into operation several controllers in which we depart from the usual method of applying d-c to an a-c wound rotor motor when used on a crane hoist.

The system that has been developed uses the standard wound rotor motor usually associated with a-c crane hoist equipment and a d-c operated magnetic brake. In lowering, the d-c power supplied to operate the brake is fed to the primary of the wound rotor motor in the form of a "teaser" current which initiates the generation of an a-c voltage in the secondary as the motor is forced to rotate by its load.

The current thus generated, or any part of it that may be required, is then rectified and reconnected to be fed back into the primary. Such a system becomes self-compensating, and with the proper design of secondary resistors, very desirable speed-load characteristics are obtained in the lowering direction. The speed torque characteristics of such a control very closely approximate and in many cases can be made better than those normally associated with the standard d-c dynamic lowering crane hoist controllers.

True, that with such a simple system on high friction cranes, the hook will not move when it is empty or when handling a light load. However, the hook can always be driven down by a driving speed point provided on the controller. This simple system is very useful, particularly on those cranes where the load on the hook during no-load conditions is sufficient to overcome the friction of the crane, and there are many applications where this condition is always present.

On such cranes where the empty hook does not have sufficient load on it to drive the motor in the downward direction, it is rather easy to overcome this difficulty by the simple addition of an ancillary motor to the crane hoist. This motor would be a small a-c wound rotor motor of just sufficient size to overcome the friction load in the hoist itself. Since the duty cycle on such a motor is going to be very light, this motor can be very small and at no time would exceed a size greater

than 10 per cent of the main driving motor. Furthermore, this motor can also be used for loading the hoist when traveling in the hoist direction in order to obtain slow hoisting speeds at no load.

We thereby have a simple hoist controller which in many cases would use nothing more than the wound rotor motor and the magnetic brake usually associated with such drives, and if one wants to add or finds it desirable to add a small ancillary motor to the hoist mechanism, it is possible to cover practically all conditions that would be encountered on a crane hoist and a system which gives us better speed torque characteristics than those usually associated with a straight d-c dynamic lowering hoist controller.

This system gives us a safe operating hoist since the load is self-compensating and the faster the motor tries to go, the more d-c current is fed back into the primary which automatically increases the retarding torque delivered by the motor and thus enables one to handle practically any load that can be lifted by the motor. By this I mean that in many cases with a wound rotor motor, it is possible to pick up a load which is three times the normal rating of the motor or the hoist, and even with this load, the hoist can be made self-compensating to the extent that it is safe to handle such a load in the lowering direction.

This system not only provides inherent retarding torque developed by the motor on lowering but also can be arranged to provide dynamic braking at the off point.

The system is quite flexible and many variations of the control can easily be made. For example, if one wants to provide a motor-generator set to provide the d-c current for braking, then one only needs to take from the secondary sufficient power to control the field of the generator and thus regulate the d-c current available for braking. This signal would again be self-compensating. Or, one might provide saturable reactors with only enough power taken from the secondary to furnish the d-c saturating current which in turn would regulate the amount of d-c current fed to the primary of the motor through saturable reactors connected to the line or through a transformer.

Several of the simpler schemes without an ancillary motor are in operation at the present time, not only in this country but also in Canada. Units are now being built incorporating the use of an ancillary motor along with the main drive motor and these units will be in operation in the near future.

**W. R. Wickerham:** The d-c braking system described presents advanced performance, and has a desirable feature in that high excitation currents are present only when they are needed. This relieves the motor of unnecessary heating for light load handling, and presents a more optimistic picture than indicated in Figure 7.

**A. H. Myles:** In the selection of crane control the user should know what features are essential, which are desirable, and which, though desirable, can be dispensed with when consideration is given to first cost, space requirements, maintenance, safety, and dependability. If certain hoist applications do require extreme refinement in operation, then the control must include the additional equipment and complications necessary to provide such operation. However, most hoist requirements are satisfied by the simplest present standard a-c crane hoist control referred to by the author. For example, the many hundreds of users of a-c dynamic braking hoist controllers find them adequate and often more than adequate for the job they are called upon to do. Their simplicity reduces maintenance to a minimum, and, inherent with simplicity of circuits, is maximum safety.

In the author's paper no circuit diagrams are shown, however, an inductor, pilot machine, and control unit are apparently all mounted on the trolley. It would appear that in addition to mounting these units and the load detector mechanism, that extra collectors are required, adding considerably to the cost and complication of the complete crane.

A study of the operating characteristics of the load-o-matic control immediately presents a question of sensitivity of the load detector. Does it cause hunting of the control if surges occur in the load for any of various reasons? Also the speed response obtained by squeezing the vernier control lever is opposite in hoisting to that in lowering presenting some confusion in operation.

The author discusses the added safety provided by the load detector in case the hoist limit switch should fail to open the motor circuit. In practice we must remember that if a hook block over-travels and contacts the drum or structure, then the benefit of multiple reeving is lost and full motor torque and inertia are applied to the single reeving. The effective cable length is short and breakage almost a certainty. It would appear that the response of the load detector would be too late to prevent dropping of the hook.

**W. R. Wickerham:** With regard to the sensitivity of the load detector and the possibility of hunting due to load surges, our tests show minor variations can be caused by a visciously swinging load or by traveling over a rough runway, however, nothing that could qualify as hunting. We would point out that there is no reason to expect close hoisting speed control with the crane in motion or the load swinging, hence hoisting speed transients under these circumstances present no hazard.

The best method of operating the vernier is a matter of opinion. Since preparation of the paper, we have about reached a decision to operate this device by an auxiliary handle on the hoist master switch, which performs similar to the main handle but with less effectiveness. (See Figure 2.) On this, we appear to have come into conformance with Mr. Myles' ideas.

**S. Rifkin** From an electrical viewpoint, the load-o-matic system seems to be entirely feasible. From a practical viewpoint, I would prefer to hear the comments of crane builders and steel mill maintenance engineers with regard to the desirability of mounting a tachometer generator, an inductor, and a spring-biased off-set overhead sheave on a crane trolley. What about the number of additional collectors between those

devices and the control panel? Many steel mill crane control panels are maintained by so-called "motor inspectors"; and an extremely competent "motor inspector" would be necessary when "trouble shooting" a system that involves saturable reactors, rectifiers, an inductor, and a tachometer generator in addition to the normal contactors, relays, and resistors. Incidentally, is an induction-replusion motor that has flexible leads brought out in place of a commutator really a standard item, as implied by the authors?

As far as the constant potential d-c dynamic braking portion of this paper is concerned, it seems to me that the author is devoted entirely too much time and space to a description of contactors and resistors, but did not say enough about the new control circuit. In the sequence chart of Mr. Mathias's Figure 4, I wonder if the IM contactor should not be closed on the first lowering point; otherwise the motor would not be connected to the power supply, and could not develop the 27 per cent kick-off torque shown for that point in Mr. Mathias's Figure 1. One other comment that comes quickly to mind when looking at the power circuit in Figure 4 is the dangerous condition that exists if the operator moves the master switch back to the second hoisting point just before a power-type limit switch is tripped by an empty hook running up at fast speed. As pointed out in my discussion following the article entitled "An Improved d-c Crane Hoist Control" in the October, 1950, issue of "Iron and Steel Engineer," the motor shunt connection through the normally-closed contactor would keep the brake released under that condition, and the stored energy in the rotating system might be more than enough to snap the cable if the hook runs into the overhead sheaves. On the first hoisting point, a plugging connection could be established by contactor IM when the limit switch trips, but the authors do not give any indication as to whether or not the magnitude of that plugging torque would be adequate to prevent damage.

Referring to the adjustable-voltage control system with a compound wound motor, it would be interesting to know whether the condensed oscillograms shown in the paper were taken with a dynamometer load, or with an actual hoist installation. The problem of making certain that the electrical time constant of the system is longer than the mechanical time constant cannot be passed over lightly. If the motor speed cannot respond very rapidly to a change in motor current, a very severe oscillating condition is likely to be encountered when the master switch is moved rapidly from "off" to the full speed lowering position.

**W. R. Wickerham:** It is a fact that when compared to other systems giving precision control, two additional control collectors will be required on the average. A number of equipments are presently under construction which will employ 3-phase trolley-duct (rated 90-amp–440-v) for this purpose. Space for extra collectors is often more of a problem than cost, and use of the trolley duct is a solution of the space problem.

With regard to trouble shooting, we would suggest that outside of the main reactors there are no devices or circuits used that are uncommon. While the main reactor performance might constitute somewhat of a mystery to an electrician, they are static and should never require servicing, and we intend to guarantee this by employing liberal designs. The system that preceded the load-o-matic employed the same reactors, and with a large number in service beginning 10 years ago, we have not had a reported failure. As compared to the preceding system, the load-o-matic uses a greatly simplified excitation circuit (Figure 1), one which employs the d-c machine, a standard transformer,

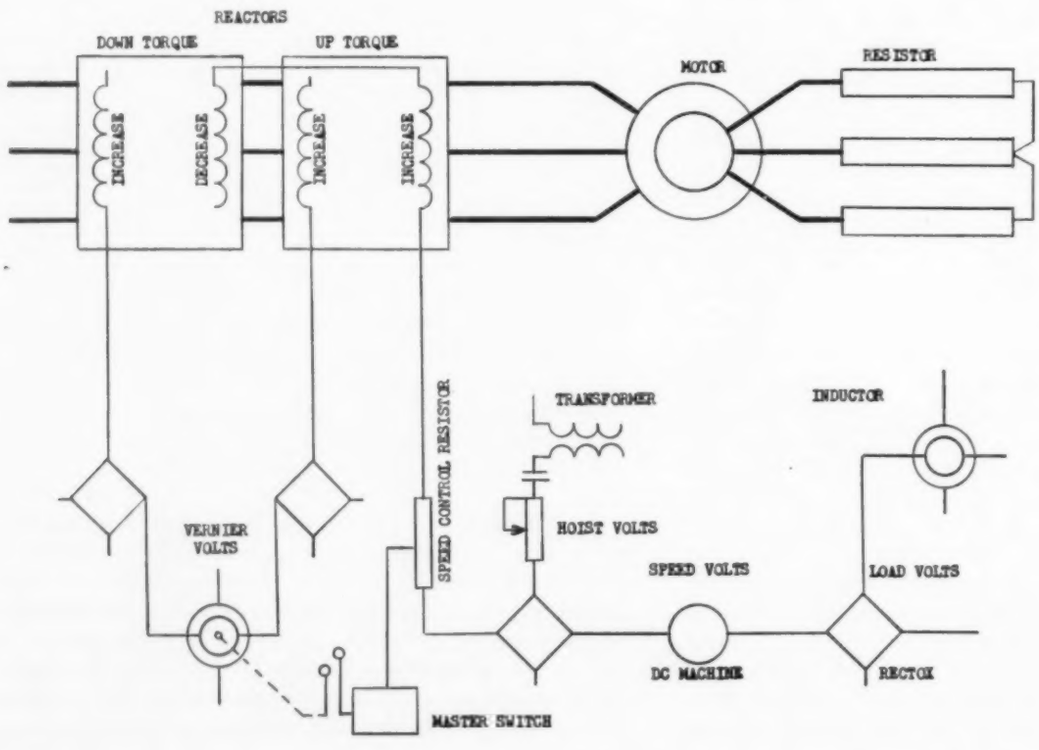



**Figure 1 — Excitation circuit is quite simple.**

two "transformers with movable secondaries," and metallic rectifiers. There are no mysteries about this circuit, and the performance of the components are common knowledge. It perhaps should be pointed out that failure of one or more of the components of the excitation circuit does not immobilize the crane. Without the vernier excitation, the performance is equal to the best provided by other systems. In the hands of a trained operator, the functions of either the load detector or the pilot machine may be taken over for emergency operation, in the event of the failure of one or both of these devices.

The components used in any control determine to a great extent the operating performance and reliability of the entire system. It is generally agreed that the contactors are the heart of the constant potential d-c dynamic braking crane hoist control. A new contactor is now available having been developed for this severe type of service. It was felt those actually using and maintaining this type of equipment would be interested in the special features of the new Type M contactors.

We wish to thank Mr. Rifkin for pointing out a typographical error. Contactor IM must be closed in the first lowering point even though the sequence chart did not show this.

The problem of hoist limit switch operation is a study within itself. We definitely feel it desirable to provide the operator with a stable slow hook speed at no load. This is accomplished by means of armature shunt and motor shunt connections. When the hoist limit switch is tripped, the motor armature and its series field are reconnected in series with a braking resistor so that with self excitation dynamic braking is obtained and also, the series brake sets. To make certain that the series brake sets even on the first or second hoisting points, and auxiliary shunt wound relay is provided to open the series brake circuit when the power limit switch trips.

All the oscillograms of the adjustable voltage hoist control system included in this paper were taken on an actual hoist installation and not with a dynamometer. It would be very difficult to simulate on a dynamometer, the transient conditions occurring on a hoist. It is quite true that the problem of making the electrical time constant of the system longer than the mechanical time constant cannot be passed over lightly. In this system without an additional rotating regulator the problem of stability is simplified because the time delay of a rotating regulator is not present.


**STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC. OF**

## IRON AND STEEL ENGINEER

(Required by the Acts of Congress of August 24, 1912, March 3, 1933 and July 2, 1946)

Name of Publication: *Iron and Steel Engineer*, published monthly at Pittsburgh, Pennsylvania. (Report of October 1, 1952.)

State of Pennsylvania
County of Allegheny

Before me, a notary public in and for the State and county aforesaid, personally appeared T. J. Ess, who, having been duly sworn according to law, deposes and says that he is the editor of the *Iron and Steel Engineer* and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Acts of March 3, 1933 and July 2, 1946, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher: Association of Iron and Steel Engineers, 1010 Empire Building, Pittsburgh, Pennsylvania.
Editor: T. J. Ess, 1010 Empire Building, Pittsburgh, Pennsylvania.
Managing Editor: None.
Business Manager: None.

2. That the owner is: Association of Iron and Steel Engineers, 1010 Empire Building, Pittsburgh, Pennsylvania.

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# COKE AND BY-PRODUCTS IN 1951

*. . . . data from the Mineral Market Reports M.M.S. No. 2086, July 1952; M.M.S. No. 2092, August, 1952; and M.M.S. 2099, October 7, 1952 . . . .*

▲ A new all-time peak in coke production in the United States was attained in 1951, according to data submitted by coke producers to the Bureau of Mines, United States Department of the Interior. A total of 79,330,702 net tons of coke, excluding breeze, was produced which represented a gain of 9 per cent over the 1950 output and exceeded the previous maximum of 1948 by 4,468,774 tons. This record was made possible by the efficient coordination of labor and management in the mining, transportation, steel, and other basic industries which permitted coke producers to maintain extremely high-operating rates throughout the year. Slot-type coke ovens operated at the second highest production rate on record—96.5 per cent of capacity, compared with the all-time peak rate of 96.9 per cent during 1942, the first year of World War II. Beehive-coke production, the highest since 1943, declined slightly in the latter months of the year from the high rate in January and was 9 per cent of the total coke production.

One of the major problems that confronted the coke industry in 1951 was providing sufficient coal-carbonizing capacity to support the double burden of the accelerated general industrial activity and the national defense program. A total of 696 new slot-type coke ovens

**TABLE I**

**Statistical Trends of the Coke Industry in the United States**

| | 1937 | 1948 | 1949 | 1950 | 1951 |
|---|---|---|---|---|---|
| Production: | | | | | |
| Oven coke, net tons | 49,210,748 | 68,284,357 | 60,222,481 | 66,890,618 | 71,987,172 |
| Beehive coke, net tons | 3,164,721 | 6,577,571 | 3,414,948 | 5,827,420 | 7,343,530 |
| Total, net tons | 52,375,469 | 74,861,928 | 63,637,429 | 72,718,038 | 79,330,702 |
| Per cent oven coke | 94.0 | 91.2 | 94.6 | 91.8 | 90.7 |
| Stocks of coke, end of year, net tons | 2,595,287 | 1,593,441 | 1,769,456 | 1,110,714 | 1,482,972 |
| Exports, all coke, net tons | 526,683 | 706,190 | 548,256 | 397,846 | 1,026,730 |
| Imports, all coke, net tons | 286,364 | 161,400 | 277,507 | 437,585 | 161,639 |
| Indicated consumption, all coke, net tons | 51,271,929 | 73,755,934 | 63,190,665 | 73,416,519 | 78,093,353 |
| Disposal, all coke sold or used: | | | | | |
| Furnace coke, net tons | 36,751,969 | 59,285,506 | 51,514,853 | 60,918,549 | 67,440,987 |
| Foundry coke, net tons | 2,038,822 | 3,750,659 | 2,778,868 | 3,523,396 | 3,805,686 |
| Other industrial coke (including producer and water gas), net tons | 4,597,894 | 7,733,382 | 6,412,672 | 6,366,497 | 5,603,262 |
| Domestic coke, net tons | 8,107,518 | 3,445,309 | 2,755,840 | 2,565,176 | 2,087,934 |
| Carbonizing equipment: | | | | | |
| By-product ovens in existence, end of year | 12,718 | 15,139 | 15,104 | 14,982 | 15,319 |
| Beehive ovens in existence, end of year | 12,194 | 14,078 | 13,662 | 17,708 | 20,458 |
| By-product ovens under construction, end of year | 259 | 350 | 562 | 706 | 398 |
| Cost of coal charged, oven-coke plants average per ton | $3.74 | $8.13 | $8.52 | $8.67 | $8.94 |
| Prices of coke: | | | | | |
| Average realization on oven coke sold (merchant sales): | | | | | |
| Furnace coke | $4.34 | $13.78 | $14.09 | $14.31 | $15.64 |
| Foundry coke | $8.47 | $18.78 | $19.72 | $20.05 | $22.19 |
| Other industrial coke (including water gas) | $6.08 | $13.45 | $13.74 | $14.10 | $14.44 |
| Domestic coke | $6.53 | $13.17 | $13.50 | $13.60 | $14.45 |
| Yield of by-products per ton of coal charged: | | | | | |
| Tar, gal | 8.67 | 7.60 | 7.81 | 7.79 | 7.78 |
| Ammonium sulphate or equipment, lb | 21.84 | 19.52 | 20.08 | 19.89 | 19.82 |
| Crude light oil, gal | 2.86 | 2.73 | 2.77 | 2.81 | 2.83 |
| Surplus gas sold or used, M cu ft | 6.66 | 6.25 | 6.35 | 6.36 | 6.38 |
| Average gross receipts for by-products, per ton of coke produced: | | | | | |
| Tar sold and used | $0.502 | $0.828 | $0.722 | $0.691 | $0.757 |
| Ammonia and its compounds | $0.326 | $0.545 | $0.558 | $0.468 | $0.501 |
| Crude light oil and its derivatives (including naphthalene) | $0.435 | $0.685 | $0.673 | $0.871 | $1.179 |
| Surplus gas sold or used | $1.483 | $1.839 | $2.015 | $1.977 | $1.921 |
| Total coal-chemical materials (including breeze) | $2.974 | $4.419 | $4.447 | $4.508 | $4.927 |

with a designed annual coke capacity of 3,869,100 tons was completed, while 359 ovens, having an annual coke capacity of 1,709,100 tons, were taken out of production. Most of the 359 ovens were shut down for rebuilding, although one coke plant with 42 ovens closed permanently and several batteries at other plants were completely demolished. Although the difference between capacity of the new ovens completed and old ovens taken out of production was 2,160,000, the net gain in potential capacity during the year was only 1,740,200 tons. This was due to slowing down the coking cycles for the older ovens during the year. About 52 per cent of all slot-type coke ovens in existence on December 31, 1951, were at least 20 years old. Many of these ovens were reported to be in poor physical condition, and coke producers were faced with the difficult task of maintaining existing capacity as well as constructing additional ovens to support the expansion in the iron and steel industry. In an effort to meet the planned expansion goal for coke capacity, the industry had 1,446 new ovens with a designed annual coke capacity of 8,134,500 tons under construction on December 31, 1951, and contracts for a number of additional batteries were pending. However, all of the new construction will not represent additional capacity as a large part will actually be replacement of badly deteriorated ovens.

Production of basic chemical raw materials, which generally parallels oven-coke output, also reached new peaks in 1951. Increases of 8 per cent, 9 per cent, and 8 per cent over 1950 were registered by ammonia (all forms), crude light oil, and tar, respectively. These gains resulted in corresponding increases in the output of derivatives as follows: benzol (chemical grades), 12 per cent; toluol (all grades), 12 per cent; xylol, 13 per cent; naphthalene, 31 per cent; creosote oil, 14 per cent; crude chemical oil, 41 per cent; refined pyridine, 26 per cent; ammonium sulfate, 8 per cent; and ammonia liquor, 6 per cent. In spite of the gains in output of benzol and naphthalene, requirements exceeded production from domestic sources, and considerable quantities of these commodities were imported from abroad. Although the supply of virtually all of the principal coal chemicals was limited, they were not placed under allocation control, and only directive actions were taken from time to time on some of the scarcer commodities, particularly toluol for use in explosives and benzol to fill in spot shortages where urgent need arose. Benzol, toluol, and naphthalene were, however, under priority Regulation No. 1, governing inventory control. Total value of coke and breeze produced and coal chemical materials sold exceeded $1,000,000,000 for the fifth consecutive year, totaling $1,474,393,202.

## PRODUCTION OF COKE

The average daily production rate of by-product coke in 1951 was 197,000 tons; the average daily production from beehive ovens was 20,000 tons. Leading states in the order of their importance in the production of by-product coke were Pennsylvania, Ohio, Indiana, Alabama and New York. These five states combined produced about 49,147,000 tons or 68.2 per cent of the national production of by-product coke. This compares with 69.2 per cent for the year 1950. The leading producer of beehive coke was Pennsylvania with 6,396,480 tons or 87.1 per cent of the total beehive production. In 1950, Pennsylvania produced 5,193,191 tons of beehive coke. Of all the coke produced, Pennsylvania was by far the leading producer with 23,646,697 tons of the total 79,330,702 tons or 29.8 per cent. This is a slight increase over the 29.6 per cent share which Pennsylvania had in 1950.

## NUMBER AND CAPACITY OF OVENS

There were 15,319 by-product ovens in existence at the end of 1951 with a total annual capacity at the end of the year of 74,228,400 tons. This is a slight increase over the 14,982 ovens in existence at the end of 1950 which had an annual capacity of 72,488,200 net tons. During the year, 359 ovens were dismantled and 696 ovens were put into service with an annual capacity of 3,869,100 net tons. There were 1,446 by-product ovens with an annual capacity of 8,134,500 net tons under construction as of December 31, 1950. There were 20,458 beehive ovens in existence with an annual capacity of 13,858,900 tons of which 15,700 with an annual capacity of 10,646,700 tons were in operating condition at the end of the year. There were 671 beehive ovens rebuilt in 1950. All of them except 35 were in Pennsylvania. Some 51 beehive ovens were abandoned during the year, 48 in Pennsylvania and 3 in Virginia. There were 398 such ovens under construction at the end of the year.

The heavy coke oven building program which is under way, has finally reached a rate where replacements have matched obsolescence, however, there is an increase in the demand because of the additional steel capacity which has gone into operation. As a result, metallurgical coke requirements for blast furnace operations make it necessary for such units to draw on beehive, merchant and utility coke plants. In addition, imports of coke during the year totaled 161,639 tons which is much less than the 437,585 tons imported in 1950. Exports totaled 1,026,730 net tons compared with 397,846 in 1950. Thus exports exceeded imports reversing the balance which occurred in 1950.

## COAL CHARGED INTO COKE OVENS

In 1951, 113,685,882 net tons of coal were charged into coke ovens. Of this 102,267,417 tons, valued at $914,142,702 or $8.94 per ton were charged into slot-type ovens, and 11,418,465 tons valued at $7,212,117 or $6.15 per ton were charged into beehive ovens. Included in this figure are 237,136 tons of anthracite valued at $1,959,021 or $8.26 a ton which were charged into slot ovens.

The cost of coal (1.42 tons) needed to make one ton of by-product coke was $12.70 in 1951 compared with $12.31 in 1950. Similarly the cost of coal, (1.55 tons) required to make one ton beehive coke was $9.56 a ton in 1951 compared with $8.89 a ton in 1950. The trend towards washed coal continued, and of the 102,267,417 tons of coal which were charged into by-product ovens, 51,053,742 tons were washed compared with 37,792,326 tons which were washed in 1950. The percentage of washed coals is, therefore, 49.9 per cent, up from 34.9

## TABLE II

### Salient Statistics of the Coke Industry in the United States in 1951

| | | By-product | Beehive ovens | Total |
|---|---|---|---|---|
| Coke produced — At merchant plants | net tons | 13,190,550 | (1) | (1) |
| At furnace plants | net tons | 58,796,622 | (1) | (1) |
| Total | net tons | 71,987,172 | 7,343,530 | 79,330,702 |
| Screenings or breeze produced | net tons | 5,125,834 | 87,653 | 5,213,487 |
| Coal charged into ovens | net tons | 102,267,417 | 11,418,465 | 113,685,882 |
| Average value of coal per ton | | $8.94 | $6.15 | $8.66 |
| Average yield in per cent of total coal charged — | | | | |
| Coke | | 70.39 | 64.31 | 69.78 |
| Breeze (at plants actually recovering) | | 5.01 | 2.47 | 4.93 |
| Ovens — In existence January 1 | | 14,982 | 17,708 | 32,690 |
| In existence December 31 | | 15,319 | 20,458 | 35,777 |
| Dismantled during year | | 359 | 51 | 410 |
| In course of construction December 31 | | 1,446 | 398 | 1,844 |
| Annual coke capacity December 31 | net tons | 74,228,400 | 13,858,900 | 88,087,300 |
| Coke used by producer — In blast furnaces | net tons | 44,629,127 | 370,732 | 44,999,859 |
| In foundries | net tons | 59,397 | ..... | 59,397 |
| To make producer gas | net tons | 578,284 | ..... | 578,284 |
| To make water gas | net tons | 1,028,521 | ..... | 1,028,521 |
| For other purposes | net tons | 339,018 | 1,579 | 340,597 |
| Coke sold — To financially affiliated companies — | | | | |
| For blast furnace use | net tons | 11,256,984 | 1,771,379 | 13,028,363 |
| For foundry use | net tons | 57,665 | ..... | 57,665 |
| For manufacture of water gas | net tons | 663,144 | ..... | 663,144 |
| For other purposes | net tons | 301,363 | 5 | 301,368 |
| To other consumers — | | | | |
| For blast furnace use | net tons | 5,139,935 | 4,272,830 | 9,412,765 |
| For foundry use | net tons | 3,460,528 | 228,096 | 3,688,624 |
| For manufacture of water gas | net tons | 516,005 | 114,473 | 630,478 |
| For other industrial use | net tons | 1,505,695 | 555,175 | 2,060,870 |
| For domestic use | net tons | 2,060,697 | 27,237 | 2,087,934 |
| Disposal of screenings or breeze — | | | | |
| Used by producer — For steam | net tons | 3,228,179 | 3,453 | 3,231,632 |
| To make producer or water gas | net tons | 118,878 | ..... | 118,878 |
| For other purposes | net tons | 855,351 | 11 | 855,362 |
| Sold | net tons | 1,237,788 | 75,652 | 1,313,440 |
| Average receipts per ton sold (merchant sales) | | | | |
| Furnace coke | | $15.64 | $14.20 | $14.99 |
| Foundry coke | | $22.19 | $16.08 | $21.81 |
| Water-gas coke | | $15.82 | $15.35 | $15.73 |
| Other industrial coke | | $13.97 | $14.41 | $14.09 |
| Domestic coke | | $14.45 | $13.02 | $14.43 |
| Screenings or breeze | | $ 4.69 | $ 3.08 | $ 4.59 |
| Stocks on January 1, 1952: | | | | |
| Furnace coke | net tons | 1,011,989 | 14,129 | 1,026,118 |
| Foundry coke | net tons | 16,140 | 1,344 | 17,484 |
| Domestic and other coke | net tons | 439,270 | 100 | 439,370 |
| Screenings or breeze | net tons | 820,892 | 5,413 | 826,305 |
| Exports | net tons | (1) | (1) | 1,026,730 |
| Imports | net tons | (1) | (1) | 161,639 |
| Indicated consumption | net tons | (1) | (1) | 78,093,353 |
| By-products produced — Tar | gal | 795,311,283 | ..... | 795,311,283 |
| Ammonium sulphate or equivalent | lb | 1,995,546,999 | ..... | 1,995,546,999 |
| Gas | M cu ft | 1,052,280,603 | ..... | 1,052,280,603 |
| Burned in coking process | per cent | 36.19 | ..... | 36.19 |
| Surplus sold or used | per cent | 62.09 | ..... | 62.09 |
| Wasted | per cent | 1.72 | ..... | 1.72 |
| Crude light oil | gal | 284,496,933 | ..... | 284,496,933 |
| Yield of by-products per ton of coal — | | | | |
| Tar | gal | 7.78 | ..... | 7.78 |
| Ammonium sulphate or equivalent | lb | 19.82 | ..... | 19.82 |
| Gas | M cu ft | 10.29 | ..... | 10.29 |
| Crude light oil | gal | 2.83 | ..... | 2.83 |
| Coal used per ton of coke | tons | 1.42 | 1.55 | 1.43 |
| Value of coke at ovens | | $1,017,065,551 | $102,408,135 | $1,119,473,686 |
| Value of screenings or breeze | | $19,832,315 | $212,956 | $20,045,271 |
| Value of by-products sold — Tar sold | | $43,546,155 | ..... | $43,546,155 |
| Used by producer | | 10,939,886 | ..... | $10,939,886 |
| Ammonia (sulphate and liquor) | | $36,032,105 | ..... | $36,032,105 |
| Gas (surplus) | | $138,300,299 | ..... | $138,300,299 |
| Crude light oil and derivatives | | $78,024,932 | ..... | $78,024,932 |
| Other coal-chemical materials(2) | | $28,030,868 | ..... | $28,030,868 |
| Total value of coke and breeze produced and coal-chemical materials sold(3) | | $1,371,772,111 | $102,621,091 | $1,474,393,202 |

(1) Not separately recorded. (2) Naphthalene, tar derivatives, and miscellaneous coal-chemical materials.
(3) Includes value of tar used by producer, and coke and breeze produced.

per cent in 1950. At the beehive ovens, 1,990,141 tons were washed, of the 11,418,465 tons charged.

The leading states in the mining of coking coal in order of importance are West Virginia, Pennsylvania, Kentucky, Alabama. Of the 102,580,055 tons which were used, West Virginia produced 35,868,083 tons; Pennsylvania 34,834,270 tons; Kentucky 13,652,463 tons, and Alabama the fourth state produced 8,941,660 tons.

## COKE PRODUCED AND SOLD OR USED BY PRODUCERS

The total quantity of coke reported used in blast fur-

### TABLE III

**Coke produced, value, number of ovens, coal charged, and average yield in the United States in 1951, by States**

| State | Oven coke | | | | | | | Beehive coke | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plants | Ovens | Coal charged (net tons) | Yield of coke from coal (per cent) | Coke produced (net tons) | Value of coke at ovens | | Ovens | Coal charged (net tons) | Yield of coke from coal (per cent) | Coke produced (net tons) | Value of coke at ovens | | Coke produced (net tons) | Value of coke at ovens |
| | | | | | | Total | Per ton | | | | | Total | Per ton | | |
| Alabama | 7 | 1,340 | 8,756,422 | 71.85 | (4) 6,291,280 | $75,124,573 | $11.94 | .... | ..... | ..... | ..... | ..... | ..... | 6,291,280 | $75,124,573 |
| California | 1 | 135 | 924,537 | 61.46 | 568,216 | (1) | (1) | .... | ..... | ..... | ..... | ..... | ..... | 568,216 | (1) |
| Colorado | 1 | 266 | 1,452,062 | 68.55 | 995,332 | (1) | (1) | 20 | 1,300 | 55.08 | 716 | (1) | (1) | 996,048 | (1) |
| Illinois | 8 | 900 | 5,214,085 | 70.69 | 3,685,662 | 62,052,609 | 16.84 | .... | ..... | ..... | ..... | ..... | ..... | 3,685,662 | 62,052,609 |
| Indiana | 5 | 1,955 | 12,320,739 | 71.78 | (3) 8,843,452 | 156,205,401 | 17.66 | .... | ..... | ..... | ..... | ..... | ..... | 8,843,452 | 156,205,401 |
| Maryland | 1 | 551 | 3,955,067 | 72.19 | 2,855,209 | (1) | (1) | .... | ..... | ..... | ..... | ..... | ..... | 2,855,209 | (1) |
| Massachusetts | 1 | 204 | 1,561,541 | 71.01 | 1,108,826 | (1) | (1) | .... | ..... | ..... | ..... | ..... | ..... | 1,108,826 | (1) |
| Michigan | 4 | 584 | 4,001,353 | 72.98 | 2,920,082 | 44,321,098 | 15.18 | .... | ..... | ..... | ..... | ..... | ..... | 2,920,082 | 44,321,098 |
| Minnesota | 3 | 240 | 1,338,937 | 72.59 | 971,913 | 16,143,039 | 16.61 | .... | ..... | ..... | ..... | ..... | ..... | 971,913 | 16,143,039 |
| New Jersey | 2 | 341 | 2,124,486 | 72.44 | 1,538,953 | (1) | (1) | .... | ..... | ..... | ..... | ..... | ..... | 1,538,953 | (1) |
| New York | 7 | 1,115 | 8,095,523 | 69.31 | (5) 5,610,975 | 80,327,062 | 14.32 | .... | ..... | ..... | ..... | ..... | ..... | 5,610,975 | 80,327,062 |
| Ohio | 15 | 2,285 | 15,858,101 | 70.32 | (2) 11,151,201 | 146,140,699 | 13.11 | .... | ..... | ..... | ..... | ..... | ..... | 11,151,201 | 146,140,699 |
| Pennsylvania | 13 | 3,710 | 25,127,515 | 68.65 | (1) 17,250,217 | 220,910,330 | 12.81 | 17,596 | 9,872,414 | 64.79 | 6,396,480 | $87,877,904 | $13.74 | 23,646,697 | 308,788,234 |
| Tennessee | 1 | 44 | 322,037 | 77.84 | 250,658 | (1) | (1) | 90 | 3,440 | 47.62 | 1,638 | (1) | (1) | 252,296 | (1) |
| Texas | 2 | 125 | 1,041,766 | 72.51 | 755,418 | (1) | (1) | .... | ..... | ..... | ..... | ..... | ..... | 755,418 | (1) |
| Utah | 2 | 308 | 1,934,422 | 63.41 | 1,226,536 | (1) | (1) | 797 | 183,830 | 55.31 | 101,672 | (1) | (1) | 1,328,208 | (1) |
| West Virginia | 5 | 705 | 5,366,963 | 71.36 | 3,829,879 | 44,416,343 | 11.60 | 748 | 492,062 | 58.35 | 287,116 | 4,453,445 | 15.51 | 287,116 | 4,453,445 |
| | | | | | | | | 1,012 | 686,230 | 62.98 | 432,155 | 6,407,259 | 14.33 | 4,262,034 | 50,823,602 |
| Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin | 5 | 511 | 2,871,861 | 74.28 | 2,133,363 | 34,211,525 | 16.04 | 195 | 179,189 | 69.06 | 123,753 | (1) | (1) | 2,257,116 | (1) |
| Undistributed | .... | ..... | ..... | ..... | ..... | 137,212,872 | 14.76 | .... | ..... | ..... | ..... | 3,669,527 | 16.11 | ..... | 175,093,924 |
| Total 1951 | 83 | 15,319 | 102,267,417 | 70.39 | 71,987,172 | 1,017,065,551 | 14.13 | 20,458 | 11,418,465 | 64.31 | 7,343,530 | 102,408,135 | 13.95 | 79,330,702 | 1,119,473,686 |
| At merchant plants | 27 | 2,958 | 18,322,799 | 71.99 | 13,190,550 | 218,174,099 | 16.54 | | | | | | | | |
| At furnace plants | 56 | 12,361 | 83,944,618 | 70.04 | 58,796,622 | 798,891,452 | 13.59 | | | | | | | | |
| Total 1950 | 84 | 14,982 | 94,926,310 | 70.47 | 66,890,618 | 899,667,327 | 13.45 | 17,708 | 9,088,385 | 64.12 | 5,827,420 | 77,235,875 | 13.25 | 72,718,038 | 976,903,202 |

(1) Included with "Undistributed" to avoid disclosure of individual operations.

naces was 67,440,987 tons or 86.4 per cent of the total 78,093,353 tons used. This is higher than the 61,039,227 tons or 83.1 per cent of the total consumed in 1950. The percentage used in blast furnaces thus rose 3.3 per cent. The coke used per net ton of pig iron and ferro-alloys was 1,870.7 lb compared with 1,865.5 lb in 1950 thus reversing the downtrend of the previous three years. Since the yield of coke from coal was 69.78 per cent, 2,680.1 lb of coking coal were used per net ton of pig iron and ferro-alloys. The total sales of by-product and beehive coke, to other than affiliated companies for blast furnace use was 9,412,765 tons. Coke sold for domestic use totaled 2,087,934 tons, down appreciably from the 2,565,176 tons which were sold for domestic use in 1950.

### STOCKS OF COKES AND COKING COAL

According to the reports of by-product coke plants as of January 1, 1952, stocks of furnace and foundry coke totaled 1,028,129 tons; domestic and other coke totaled 439,270 tons and the stock of coke breeze was 826,305 tons. This is an increase of about 34 per cent in the level of furnace and foundry coke, and an increase of 34 per cent in the level of domestic coke from the previous year. Stocks at beehive oven plants totaled 15,473 tons, domestic and other coke totaled 100 tons, and stock of coke breeze 5,413 tons. The coke stock at beehive plants is thus about the same as the previous year.

Stocks of coal remained very uniform during the year. The inventory of bituminous coal at by-product plants reached a high of 16,960,185 tons in January, dropped to a low of 14,034,705 tons in July and recovered to a figure of 15,257,762 tons in December.

### GROSS VALUE IN YIELD IN BY-PRODUCTS

The gross value of the by-product sold in 1951, exclusive of the value of the tar used by the producer, and exclusive of the value of the coke breeze produced; but including the value of the surplus gas sold was $323,934,359 or 28.9 per cent of $1,119,473,686 the gross value of all the by-product and beehive coke produced. Average value of coke breeze and coal-chemical materials was $19.06 per ton of by-product coke produced consisting of $14.13 for the coke, and $4.93 for the coal-chemical materials and breeze. The cost of coal per ton of by-product coke was $12.70. The cost of coal per ton of beehive coke was $9.56 and the value per ton of the coke was $13.95. The average yield of the primary coke products was about the same in 1951 as in 1950. In 1951, the average yield of tar decreased slightly from 7.79 to 7.78 gal per ton of coal; ammonium sulfate or equivalent, decreased from 19.89 to 19.82 lb per ton, crude light oil increased from 2.81 to 2.83 gallons per ton and the average yield for gas decreased from 10.32 to 10.29 M-cu ft per ton.

### DISTRIBUTION OF OVEN AND BEEHIVE COKE

The largest tonnage of coke on record (78,937,869 tons) was distributed by coke-plant operators in 1951, exceeding the 1950 total by 5,564,251 tons. There was a slight change in the consumption pattern of coke during 1951. The percentage of coke used for metallurgical purposes by blast furnaces and foundry cupolas increased to 90 per cent of total coke distributed by producers as compared with 88 per cent in 1950 because of the expansion in the iron and steel industry to meet the needs of the defense program as well as maintain essential civilian requirements. The manufacture of producer gas and water gas accounted for 4 per cent of the total distributed; other industrial uses (nonferrous smelting, chemical processes, etc.), 3 per cent; household heating, 2 per cent; and 1 per cent was exported. Shipments of coke outside the continental limits of the United States, as reported by producers, was the highest since 1945.

Metallurgical coke was in extremely heavy demand because of the uninterrupted operations in the iron and steel industry in 1951, and shipments to blast furnaces and foundry cupolas in the United States totaled 70,822,992 tons, a gain of 6,547,643 tons, or 10 per cent, in excess of that for 1950. The quantity of coke used for the manufacture of producer gas and water gas combined decreased 26 per cent (1,028,174 tons) from the 1950 figure. It appears that this trend will continue as several gas utilities and chemical companies are converting their systems to natural gas as this fuel is rapidly becoming more available with the extension of pipe lines into industrial and residential areas. The quantity of coke used for other industrial purposes (nonferrous smelting, chemical processing, and miscellaneous industrial operations) increased 4 per cent over 1950. The quantity of coke distributed to the domestic trade (2,041,039) tons was the lowest since 1921. This is a highly competitive market and, due to the availability of fuel oil and natural gas, coke is no longer an important fuel for residential heating.

### CONSUMPTION BY STATES

Distribution of coke is nation-wide as indicated by the fact that it was used in each state in 1951. The leading coke-consuming states, as usual, are those that have the greatest concentration of heavy industries, particularly blast furnaces. Pennsylvania continued to lead all states in this respect, accounting for 28 per cent of all coke distributed in the United States; Ohio remained in second place with 18 per cent. Other large coke consumers are Indiana, Illinois, New York, and Alabama, in that order, which combined accounted for 32 per cent of the United States consumption. Maryland and Michigan are the only other states that used more than 2,000,000 tons each. The remaining 14 per cent was distributed to the 40 other states and the District of Columbia.

In 1951, Pennsylvania with 31 per cent and Ohio with 19 per cent accounted for more than one-half of the blast-furnace coke consumed in the United States. In addition to Pennsylvania and Ohio, 16 other states received blast-furnace coke. Although the tonnage of coke used in foundry cupolas is only 5 per cent of the total used in blast furnaces, shipments were reported to all states except Nevada and Wyoming and the District of Columbia. Michigan, the center of the automotive industry, was the leading consumer followed by

## TABLE IV

**Coal-Chemical Materials Obtained from Coke-Oven Operations in the United States in 1951**(1)

(Exclusive of breeze)

| Product | Produced | Sales | | | On hand Dec. 31 |
|---|---|---|---|---|---|
| | | Quantity | Value | | |
| | | | Total | Average | |
| Tar ..... gal | 795,311,283 | 438,733,344 | $ 43,546,155 | $0.099 | 30,741,516 |
| Tar derivatives: | | | | | |
| Creosote oil, distillate as such ..... gal | 35,251,642 | 34,168,687 | 6,226,175 | 0.182 | 1,540,890 |
| Creosote oil, in coal-tar solution ..... gal | 7,720,374 | 5,141,953 | 822,094 | 0.160 | 371,902 |
| Chemical oil ..... gal | 24,896,700 | 23,851,391 | 6,562,251 | 0.275 | 318,955 |
| Phenol ..... lb | 7,965,423 | 6,432,548 | 945,699 | 0.147 | 156,610 |
| Pitch of tar: | | | | | |
| Soft(2) ..... net tons | 561,091 | 15,563 | 508,027 | 32.643 | 5,267 |
| Hard(3) ..... net tons | 285,345 | 26,635 | 531,605 | 19.959 | 2,602 |
| Other tar derivatives(4) ..... | ..... | ..... | 1,887,681 | ..... | ..... |
| Ammonia: | | | | | |
| Sulfate(5) ..... lb | 1,796 525,451 | 1,823,499,518 | 34,240,859 | 0.019 | 82,689,087 |
| Liquor (NH- content) ..... lb | 49,755,337 | 45,295,654 | 1,791,246 | 0.040 | 1,744,378 |
| Total ..... lb | ..... | ..... | 36,032,105 | ..... | ..... |
| Sulfate equivalent of all forms ..... lb | 1,995,546,999 | 2,004,682,134 | ..... | ..... | 89,666,599 |
| NH- equivalent of all forms ..... lb | 498,886,750 | 501,170,534 | ..... | ..... | 22,416,650 |
| Gas: | | | | | |
| Used under boilers, etc. ..... M cu ft | (6)1,052,280,603 | 42,131,852 | 5,355,614 | 0.127 | ..... |
| Used in steel or allied plants ..... M cu ft | | 428,652,885 | 73,824,951 | 0.172 | ..... |
| Distributed through city mains ..... M cu ft | | 137,617,776 | 51,850,508 | 0.377 | ..... |
| Sold for industrial use ..... M cu ft | | 44,948,172 | 7,269,226 | 0.162 | ..... |
| Total ..... M cu ft | (6)1,052,280,603 | 653,350,685 | 138,300,299 | 0.212 | ..... |
| Crude light oil ..... gal | (7)284,496,933 | 17,667,570 | 3,728,340 | 0.211 | 4,270,644 |
| Light oil derivatives: | | | | | |
| Benzol: | | | | | |
| Motor ..... gal | 5,103,677 | 5,189,155 | 1,503,048 | 0.290 | 355,916 |
| All other grades ..... gal | 172,849,275 | 171,023,942 | 57,588,706 | 0.337 | 4,904,522 |
| Toluol, crude and refined ..... gal | 34,301,508 | 34,055,449 | 10,387,291 | 0.305 | 910,124 |
| Xylol, crude and refined ..... gal | 9,097,044 | 8,847,407 | 2,811,636 | 0.318 | 618,979 |
| Solvent naphtha ..... gal | 6,036,302 | 6,039,202 | 1,389,525 | 0.230 | 354,679 |
| Other light oil products ..... gal | 6,920,644 | 4,694,176 | 616,386 | 0.131 | 311,998 |
| Total ..... gal | 234,308,450 | 229,849,331 | 74,296,592 | 0.323 | 7,456,218 |
| Intermediate light oil ..... gal | 748,162 | 718,214 | 137,150 | 0.191 | 59,839 |
| Naphthalene, crude ..... lb | 131,116,942 | 130,200,785 | 6,849,831 | 0.053 | 3,948,810 |
| Pyridine: | | | | | |
| Crude bases (dry basis) ..... gal | 536,689 | 529,242 | 845,887 | 1,598 | 122,171 |
| Refined or 2°C ..... lb | 1,478,750 | 1,484,909 | 1,440,530 | 0.970 | 15,983 |
| Sodium phenolate ..... gal | 2,800,251 | 2,483,119 | 598,806 | 0.241 | 234,243 |
| Sulfur ..... lb | 6,463,960 | 6,669,260 | 123,529 | 0.019 | 1,284,000 |
| Other coal-chemical materials(8) ..... | ..... | ..... | 551,603 | ..... | ..... |
| Value of all coal-chemical materials sold ..... | ..... | ..... | $323,934,359 | ..... | ..... |

(1) Includes products of tar distillation conducted by coke-oven operators under same corporate name. (2) Softening point less than 110 F. Includes some medium pitch-of-tar reported by two producers. (3) Softening point over 160 F. (4) Cresols, cresylic acid, fuel oil, pitch coke, road tar, tar paint, and topped tar. (5) A small amount of sulfate from purchased synthetic ammonia was produced and sold by one producer but is not included. (6) Includes gas used for heating ovens and gas wasted. (7) 270,541,072 gal refined by coke-oven operators to make derived products shown. (8) Ammonium thiocyanate, picolines, secondary oil, and sodium prussiate.

Ohio and Pennsylvania; these three states accounted for 38 per cent of the total of this grade. Of the 9 states that used coke for the manufacture of producer gas, New York consumed 34 per cent and New England states used 40 per cent. Water-gas coke produced in 15 states was distributed to 23 states, 40 per cent of the total being consumed by New York and West Virginia combined with New York, as usual, the leader, and 37 per cent by Virginia, Ohio and Massachusetts. Coke shipped for other industrial use was distributed to every state with Ohio, New York, Pennsylvania, and Michigan, in this order, receiving the bulk of the tonnage, amounting to 48 per cent of the total. Domestic coke (a space heating fuel) was distributed to all but 10 states and the District of Columbia, with Massachusetts, New York, New Jersey, and Ohio consuming more than 200,000 tons each, which combined accounted for 60 per cent of the total.

### BREEZE

The term "breeze" is used in the coke industry to designate the smaller pieces of coke which result from the screening of major sizes. Breeze has a lower unit

value than large coke, consequently most of the product is consumed, chiefly for steam raising, at or near the producing plant. As very few beehive-coke plants have breeze recovering facilities, oven-coke plants produced about 99 per cent of that distributed in 1951, and the leading producing states, Pennsylvania, Ohio, Indiana, and New York, in that order, are likewise the leading breeze consuming states, accounting for 57 per cent of the total tonnage distributed. Based on data supplied by producers, 63 per cent of breeze distributed was used for steam raising, 35 per cent for other industrial purposes, and 2 per cent for making producer gas or water gas. The demand for coke breeze in the United States in 1951 decreased 195,500 tons from 1950 to 5,503,691 tons, or 7 per cent, of the total consumption of coke and breeze.

### EFFECT OF NATURAL GAS

The expansion in natural gas distribution systems and the increased supply had a marked effect on the production of coke oven gas for domestic and commercial uses. Marketed production of natural gas in the United States climbed to 7,457,350,000,000 cu ft in 1951 from 6,282,060,000,000 in 1950. Texas, Louisiana, and New Mexico accounted for 82 per cent of the increase. Production in Pennsylvania after a long static period increased as the result of discoveries made in 1950.

The gross quantity of gas placed in underground storage in 1951 was 347,690,000,000 cu ft, more than a 50 per cent increase over the previous year. The net increase of gas in underground storage during 1951 was 138,262,000,000 cu ft.

Consumption of natural gas in the United States, in 1951 increased to 7,102,562,000,000 cu ft from 6,026,404,000,000 in 1950. North Carolina, South Carolina, Massachusetts, and New Hampshire received natural gas for the first time. Aside from Texas, California and New York showed the largest increases in consumption. In each case this increase resulted primarily from the completion of an interstate pipeline. The quantities consumed by various classes of consumers in 1951 and the per cent change compared with 1950 are as follows: residential, 1,474,725,000,000 cu ft, plus 23 per cent; commercial, 464,309, plus 20 per cent; field, 1,441,870, plus 21 per cent; petroleum refineries, 537,774, plus 18 per cent; other industrial, 3,183,884, plus 14 per cent.

The average value of natural gas at the wellhead rose from 6.5 cents per thousand cu ft in 1950 to 7.3 cents in 1951. This is the sharpest rise in the average value yet recorded during one year. Total value of marketed production at the wellhead in 1951 was $542,964,000. The total value at point of consumption of all natural gas used in the United States in 1951 was $2,118,674,000 averaging 29.8 cents per thousand cu ft. This is an increase of 3.3 cents in the average over 1950 caused in part by large expansion of consumption in areas removed from the producing fields where gas has a higher value.

Interstate shipments and exports of natural gas increased 27 per cent, maintaining the same rate of increase recorded in 1950.

The number of residential consumers of natural gas increased by 4,500,000 to 21,400,000. Half of this increase was in the number of consumers of mixed gas, primarily in New York. The number of commercial consumers increased by 300,000 to 1,600,000.


# AID DEFENSE

MORE SCRAP TODAY . . . .

MORE STEEL TOMORROW.

GET IN THE SCRAP TO KEEP STEEL COMING.

*NON-FERROUS SCRAP IS NEEDED TOO!*

# THE ATTAINMENT OF MAXIMUM OPEN HEARTH PRODUCTION

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Pittsburgh, Pa.

*. . . . from paper presented at Pittsburgh Regional Technical Meeting of the American Iron and Steel Institute, October 16, 1952 . . . .*

▲ A COMPARISON of production figures in the various open hearth shops of the steel industry shows a wide variation. Numerous yardsticks, such as tons per hour, tons per 1000 sq ft of hearth area per operating hour, tons per operating hour, and others have been used in measuring performance, but for about two years the Open Hearth Steelmaking Committee of American Iron and Steel Institute has employed the average tap-to-tap time for each shop as the most universally applicable criterion of productivity. Most steelmaking furnaces of the industry tap from 60 to 250 tons in single heat furnaces using a hot metal and scrap charge. It would appear difficult to compare performance of shops tapping such a wide range of heat sizes, but an intensive study has indicated that the tap-to-tap time range is almost independent of heat size. Table I shows a number of shops tapping from 105 to 225 net tons per heat in which the heat time varies by 12 per cent.

TABLE I

Size of Heat and Heat Time

| Shop | Size of heat, net tons | Year, 1951 average tap-to-tap time, hr |
|---|---|---|
| A | 106 | 10.3 |
| B | 123 | 9.7 |
| C | 149 | 10.1 |
| D | 163 | 10.3 |
| E | 168 | 9.1 |
| F | 180 | 10.6 |
| G | 222 | 9.7 |
| H | 225 | 10.4 |

Conversely, there are shops tapping approximately 220 tons per heat which, from the standpoint of auxiliary equipment as shown in Table II, are quite similar but which differ widely in the tap-to-tap times.

TABLE II

Comparison of Open Hearth Furnace Auxiliaries

| | Shop "M" | Shop "N" |
|---|---|---|
| No. of furnaces | 11 | 15 |
| Tap-to-tap time, hr | 9.7 | 14.1 |
| Tons tapped per heat | 222 | 216 |
| Sq ft of hearth area per ton tapped | 4.0 | 3.6 |
| Maximum Btu input per hour, million | 90 | 90 |
| Btu per ton, million | 3.050 | 4.246 |
| Charge — per cent | | |
| Hot metal | 59.8 | 55.0 |
| Pig iron and iron scrap | 2.7 | 7.2 |
| Steel scrap | 27.6 | 30.6 |
| Fe in ore and scale | 9.2 | 6.3 |
| Additions | 0.7 | 0.9 |
| Total | 100.0 | 100.0 |
| Stock yard cranes, No. | 3 | 4 |
| Lime and ore | Bins | Bucket loaded |
| Charging boxes, No. | 850 | 600 |
| Volume cu ft | 33 | 40-50 |
| No. per operating furnace | 77 | 40 |
| Charging machines | 4 | 5 |
| Hot metal ladles, No. | 8 | 5 |
| Capacity tons | 65 | 75 |
| No. per furnace charge | 3 | 2 |
| Hot metal cranes | 3 | 3 |
| Forced draft fans | 11 | 15 |
| Induced draft fans | 11 | 15 |
| Oxygen, furnaces equipped for decarbonization | 11 | None |
| Slag pots No. | 34 | 13 |
| Volume per pot | 375 | 450 |
| Pouring cranes | 4 | 4 |
| Ingot buggies | 210 | 205 |

Some plants have shown a notable improvement in the time required to make a heat. Outstanding in this respect is the shop "X." This shop in the best month, March, 1952, produced 30,901 net tons or 20.7 per cent more steel than it produced in January, 1951. It tapped the same size heat during this entire period. The decrease in monthly average tap-to-tap time for this plant "X" is shown in Figure 1.

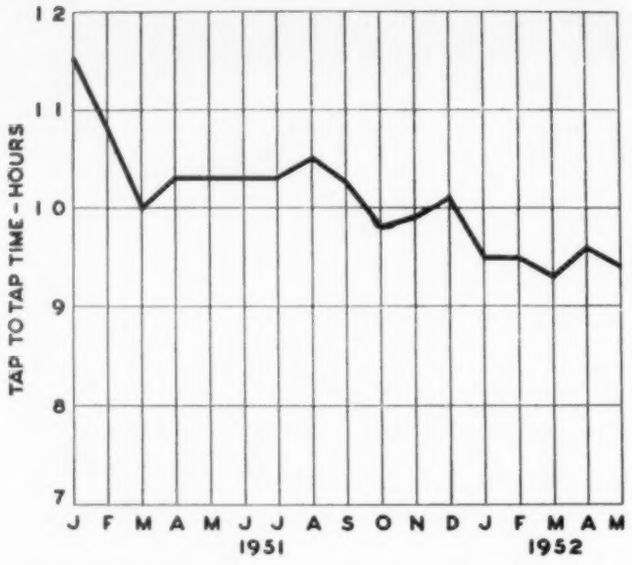



**Figure 1 — Monthly average tap-to-tap time.**

The causes of this saving of time and increase of tonnage are to be found in the improvements in practice which have occurred in each phase of the production of a heat of open hearth steel. These improved steelmaking practices will now be discussed in some detail.

## CARE OF FURNACE BOTTOM AND BANKS

Monthly reports of furnace delays usually show "Actual Fettling Time" and "Bottom and Bank Delays" separately.

Actual fettling times range from a high of 39.6 minutes per heat to a low of 22.0 minutes. In many shops, a low actual fettling time is accomplished by making up the furnace ends while the heat is being tapped. In one shop having a very low tap-to-charge time, it is standard practice to spot the dolomite machine at one end (No. 1 or No. 5 door) just before the heat is tapped.

Bottom and bank repairs vary from a low of 12.4 minutes per heat to a high of 52.6 minutes. This is quite a wide variation, and depends to some extent on the type of steel made and the age of the bottom.

Combined normal fettling and bottom and bank repair delays of 35 minutes represents an excellent performance and anything higher than 50 minutes for a monthly average leaves something to be desired.

## TEMPERATURE

The subject of temperature, what it is, its function in all high temperature operations, and how it can be secured and maintained, is the most fundamental aspect of open hearth practice. Much time and attention have been devoted to the metallurgy of steelmaking, but the first requisite is to melt rapidly and heat the charge to pouring temperature. Heat cannot be used in an open hearth furnace to melt steel until we apply sufficient temperature to bring it up to the level at which it can melt the open hearth charge. This temperature level is reached by burning fuel with preheated air. Early designs of the open hearth steelmaking furnace were not successful until the principle of regeneration was applied.

Fuel burned with cold air will not furnish heat at a high enough temperature to make steel. *Maximum speed in steelmaking is dependent upon maintaining a maximum temperature of regenerated air.* Another fundamental in open hearth operation is the delivery of a sufficient volume of preheated air to burn the desired volume of fuel.

Figure 2 shows the relation between maximum flame temperature and preheated air temperature and volume. Maximum flame temperature is assumed for purposes of illustration as that temperature which will result from the combustion of the fuel with exactly the proper volume of air (at 2200 F) for complete combustion. *The effect of air infiltration on regenerated air temperature cannot be overemphasized. Each 10 per cent of air infiltration reduces the regenerated air temperature by approximately 200 F.* The archenemy of maximum combustion temperature is either an excess or insufficient volume. The chart shows the effect of 10 per cent excess air on flame temperature and indicates that with 10 per cent excess air only 97.8 per cent of the maximum flame temperature can be developed if the air is at 2200 F and only 91.2 per cent if the air is at 1600 F. The effect of insufficient volume is approximately the same as a corresponding excess.

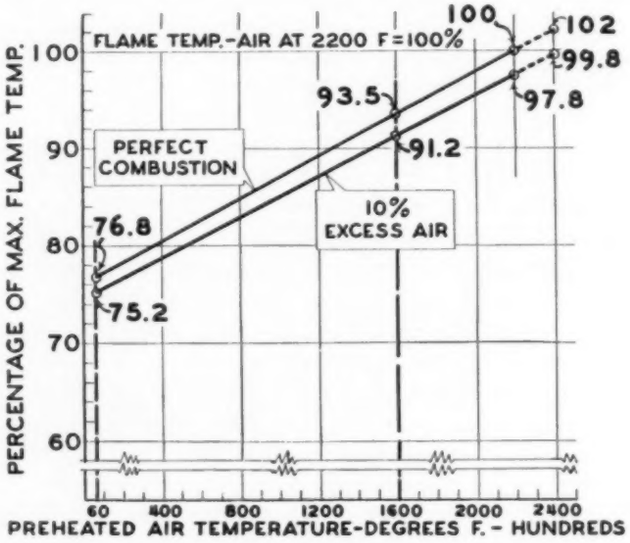



**Figure 2 — Relation between maximum flame temperature and preheated air temperature and volume.**

Usually we talk about the fuel consumption of an open hearth furnace in terms of million Btu per ton of ingots. However, again referring to the temperature essential to maximum production, Figure 3 shows the percentage of the heat in the fuel which is available to heat the charge at various temperature levels. This chart shows that above 2000 F, only 43 per cent of the heat in the fuel is available for raising the bath temperature, and above 2500 F only 33.9 per cent is available because the remainder of the heat is required simply to hold the bath at these temperatures. Transferred into cost on the basis of fuel oil at $0.10 per gallon ($0.81 per net million Btu) the heat required above 2500 F costs $2.41 per million Btu. These figures pre-

suppose that fuel is always being burned with just sufficient air for combustion at 2200 F. As the volume of air is reduced or the temperature of the regenerated air is decreased, this cost increases rapidly.

There is one other characteristic of combustion which men who run furnaces know very well, and that is that some fuels do a better job than others. Fuels rate as follows in desirability: (1) coke oven tar, (2) fuel oil, (3) natural gas, (4) coke oven gas. This is because of the fact that heat is transferred from the flame to the bath in two ways—first and best, by radiation and second, by convection. This transfer of heat by radiation is much faster than by convection. Thus, the fuel giving the highest luminosity is the most efficient.

The effect of regenerated air temperature on flame conditions has been discussed, and it should be emphasized that the conditions which promote maximum flame temperature and maximum rate of heating of the charge are:

1. Adequate checker capacity.
2. Clean checker.
3. Tight regenerators and port ends to eliminate air infiltration.
4. Proper volume of air.

Careful attention to these factors and the use of the maximum volume of fuel (90 to 100,000,000 Btu per hour on our largest furnaces during melting down) will result in a fast liquid run-off slag and will result in a minimum heat time, which of course is equivalent to the maximum production rate.

## MAINTENANCE OF MAXIMUM FURNACE TEMPERATURE

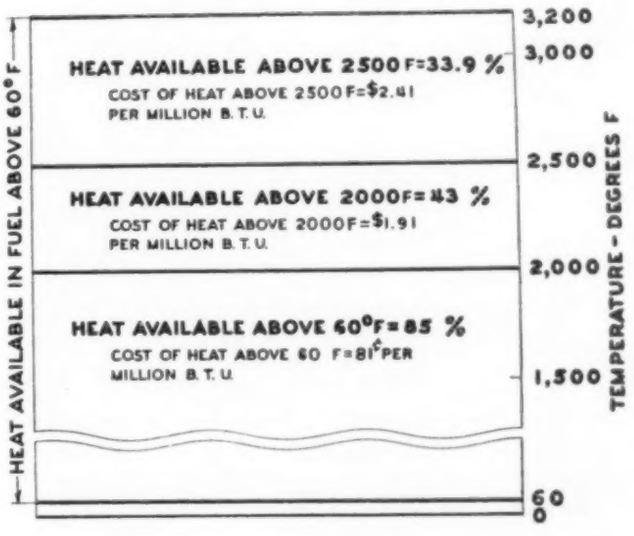
The extent to which a furnace system, particularly the regenerators, can be cooled during the tapping of a heat is not generally appreciated. On a well operated furnace, the temperature of the top checkers is 2400 F at tap. During tapping and bottom making these temperatures fall below 1800 F, due to the infiltration of cold air while furnace doors are open. This is not conducive to fast melting, because in the early stages of the heat, the flame temperature will be at its lowest point, just when the maximum air temperature is most desirable to speed up melting. A difference of 400 F in regenerated air temperature lowers flame temperature 200 F. Some plants which are making excellent heat time, keep considerable fuel on the furnace while tapping and making bottom and maintain maximum fuel input during charging, with the result that the drop in regenerated air temperature is not more than 100 F. This is a big help toward fast melting. Some shops use radiation pyrometers sighted on the hot end of the checkers, and regulate fuel flow to maintain a temperature 2300 to 2350 F. The maintenance of maximum regenerator temperatures by means of which optimum melting rates are attained is materially helped by regular checker chamber blowing. Careful attention to checker cleaning and the elimination of air infiltration into the checker chambers will pay big dividends in fast melting. In some shops, multiple pass checkers have shown as much as a 200 F increase in regenerated air temperatures over that attained with conventional single pass checker design.

On furnaces which are operated on natural draft, the maintenance of maximum checker chamber temperatures is especially important. On such furnaces the volume of air drawn into the checker chambers is controlled by the temperatures of the checkers and uptakes. After charging, when the maximum fuel firing rate is essential, cold checkers reduce the amount of air which is available and limit the firing rate at the time when the maximum rate is most necessary. Leakage in stack valves should be carefully guarded against since such leakage decreases the volume of air delivered to the regenerators and thereby reduces the rate at which fuel can be burned in the furnace.

## CHARGING

In charging a furnace, the distribution of the charge over the hearth is of prime importance. Uniform distribution of limestone, i.e., the elimination of piles, facilitates the lime boil and is conducive, under maximum bath temperature, to rapid carbon reduction and the complete solution of lime in the final slag. Many furnaces have three larger and two smaller doors, which retard uniformity of distribution of charge. At one plant, a change to five doors all of the same size and a more uniform distribution of limestone and charge ore over the bath resulted in a reduction in time of heat of 45 minutes. Some furnaces tend to run hotter on one end than the other and this should be recognized and compensated for by uneven placement of stock. Furnaces charged with high silicon iron (1.30 to 1.75 per cent) and/or high percentages of hot metal (62 to 65 per cent, based on gross metallic charge) require heavy ore charges. Such charges require considerable time to attain reaction temperature and involve much more extensive reaction time. This of course increases tap-to-tap time. The quantity and therefore the depth of ore in the furnace will vary by 100 per cent between high hot-metal, high silicon-iron charges and low hot-metal, low silicon-iron charges. Moreover the silica content of the charge ore itself, which may vary from 0.5 to 8.0 per

**Figure 3 — Fuel cost per million Btu with fuel oil cost at 10¢ a gal (regenerated air at 2200 F).**


HEAT AVAILABLE ABOVE 2500 F=33.9 %
COST OF HEAT ABOVE 2500 F=$2.41 PER MILLION B.T.U.
HEAT AVAILABLE ABOVE 2000 F=43 %
COST OF HEAT ABOVE 2000 F=$1.91 PER MILLION B.T.U.
HEAT AVAILABLE ABOVE 60°F=85 %
COST OF HEAT ABOVE 60 F=81¢ PER MILLION B.T.U.
HEAT AVAILABLE IN FUEL ABOVE 60° F
TEMPERATURE - DEGREES F
3,200
3,000
2,500
2,000
1,500
60
0

cent, has a further lengthening influence on the heat time.

The distribution of the scrap charge is governed to some extent by the sulphur content of the fuel used. With high-sulphur fuel such as coke oven gas, containing as much as six grains of sulphur per cubic foot, it is desirable in the interest of minimum melt sulphur in the bath that the heavy scrap be placed on the top. However, if low sulphur fuel is used, the fastest melting practice can be secured by exposing to the flame the maximum possible surface of the scrap. This practice requires a portion of the light scrap on the top of the charge.

*In striving for maximum production, high firing rates should be maintained throughout the charging period, shifting from end to end to insure visibility for the machine operator.*

The preparation, selection, and loading of charging boxes to insure maximum weight per box and minimum number of boxes per heat requires the best possible supervision in the stockyard, with adequate motive power promptly to convey full heat charges to the floor and remove empties.

## MELTING DOWN

After the furnace has been charged, the next operation is to bank the doors. This operation consumes from 20 to 30 minutes and requires that the space in front of the furnace be clear of charging buggies. In many plants it is customary to cut back fuel while banking doors, especially during the summer months. Few plants bank doors with full fuel, while others, especially those which carry a heavy furnace pressure, adjust the pressure controls to a lower figure at which a balanced condition exists at the wicket. Still others, where space conditions permit, use pay loaders and complete the door banking job in five to ten minutes with full fuel and pressure on furnace.

However, maintenance of the highest fuel input which the furnace can consume is essential. This can be determined from waste gas port analysis. This presupposes attention on the part of the first helper to see that the flame is not deflected to the roof by the scrap. Generally, a furnace full of unmelted scrap cannot be burned since the rate of heat absorption by the scrap keeps the flame below the temperature at which it will harm either silica or basic brick. Under maximum firing conditions and with charging times under one and one-half hours, the furnace should be ready for hot metal one hour after charging.

## HOT METAL ADDITIONS

For best practice, the furnace temperature should be high enough so that when the first ladle of hot metal is poured, a lively reaction will be initiated. Soon after the second ladle is poured (two ladles of hot metal to a heat), the run-off should commence. The early and rapid removal of the silicon in the hot metal by the flush slag promotes speed. Fuel firing rates should be maintained and the furnace watched carefully, because the chemical reaction by which silicon is removed gives off heat and too high a temperature results in blowing. For safety, no cleaning in front of the furnace should be permitted until the danger of blowing is removed.

While charging, the hunch hole should be carefully prepared by removing accumulated slag and scrap, and the hole should be closed with fresh dolomite. At the initial flush, the dolomite bank in the hunch hole should be broken down in the center to permit a good flow of slag but not so far down that the dam of dolomite will be eroded by the stream, with the resulting rush of slag, which may carry charge ore out of the furnace before it has combined with the silicon of the iron. If this occurs, a rabble should be placed in the hunch hole and a new dolomite bank built behind it.

The hunch role requires as much care and attention as the doors in front of the furnace. Every melter and first helper should regard the hunch hole as his pocketbook because time and money in added incentive pay will be the reward of careful attention to it.

## RUN-OFF SLAG AND TIME

That portion of the heat which controls the tap-to-tap time to a greater extent than any other is the run-off. The volume of the flush slag and the time required to remove it from the furnace are the keys to fast heats and maximum production.

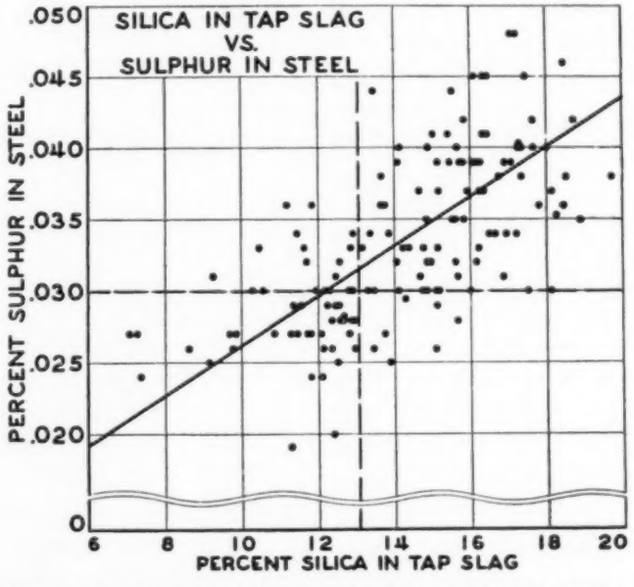



**Figure 4 — Relation between silica in tap slag and sulphur in steel.**

The run-off slag is the means of removing the silicon and phosphorous in the hot metal; the nature of the run-off slag controls the volume of tap slag and the V-value (lime-silica ratio) in the tap slag. If the silica contained in the pig iron is removed to the maximum extent by a heavy flush, the volume of the tap slag is decreased and its V-value raised. With the higher V-value, more of the sulphur in the system is absorbed in the slag with the consequent lower sulphur in the steel at tap. Many specifications, especially the low carbon steels for deep drawing, call for a maximum sulphur of 0.030 per cent; and in order to secure this low sulphur content with an inadequate flush, it may be necessary

to furnish lower sulphur hot metal from the blast furnace. This lower sulphur iron causes loss of production in blast furnace operation.

If a large and adequate flush is secured, it is possible to decrease the limestone charge at least 25 lb per ton and have the tap sulphurs no higher than they would be with a smaller volume of flush slag.

In general, heats made with tap slags having a silica content of less than 13 per cent, which is readily attainable with 200/220 lb of flush slag per ton on 60/62 per cent hot metal charge, will finish under 0.030 per cent sulphur.

Figure 4 shows a large number of heats on which the relation between silica in tap slag and sulphur in the steel has been plotted. It will be noted that heats having a tap slag containing less than 13 per cent silica finish with 80 per cent occurrence of less than 0.030 per cent sulphur, while heats having over 13 per cent silica finish with 80 per cent occurrence of over 0.030 per cent sulphur.

The following conclusions became evident as a result of tests made at one plant in which heats having a large flush were compared with heats having a normal flush. Large flush heats showed:

1. A decrease of 42 minutes in heat time.
2. A removal of the greater percentage of the silicon in the system during the flush.
3. A higher ratio of sulphur in slag to sulphur in steel at tap.
4. A lower per cent sulphur in the steel at tap (0.027 per cent for large flush heats, 0.035 per cent for normal flush heats).

To secure flushes in the order of 200/225 lb per ton on heats charged with 60/62 per cent hot metal in the shortest possible time, three things are necessary.

1. Maximum firing rates during charging, until hot metal is added and often after hot metal is added.
2. Large hunch holes (24 to 30 in. in length).
3. Elevation of hunch hole to permit maximum slag to be flushed with proper attention to maintain hunch hole elevation.

If flushing practice is not standardized and the hunch hole properly maintained, a larger than normal loss of iron will result, and the heat yield will be low. Because of the more effective removal of silicon, manganese residuals will be lower.

The value of rapid and maximum elimination of silicon is further illustrated by Figures 5 and 6. Figure 5 shows a heat, charged with high hot metal (approximately 68 per cent), which had a run-off slag of 43,130 lb or 229 lb per ton of ingots tapped. In this heat 21.5 per cent of the sulphur in the charge was removed in the run-off slag, and as a result only 39.2 per cent remained in the steel, and ladle analysis was 0.023 per cent sulphur. This heat, which tapped 188 net tons, had a time of 9 hr, 45 min. The silica content of the tap slag was 9.12 per cent and the lime-silica ratio 4.3.

The heat shown in Figure 6 from the same furnace was charged with approximately 66 per cent hot metal and had a run-off slag of 31,200 lb or 171 lb per ton of ingots tapped. In this heat only 11.6 per cent of the sulphur in the charge was removed in the run-off slag and as a result, 53.1 per cent remained in the steel and the ladle analysis was 0.035 per cent sulphur. Both heats were tapped on the same furnace and to the same specification, under 0.10 per cent carbon. The time of this heat, which tapped 181 net tons, was 10 hr, 30 min. The silica content of the tap slag was 18.34 per cent and the lime-silica ratio 2.1.

## LIME BOIL

Before the ore reactions are completed, the limestone will be heated to the point where calcining starts (about 1475 F), and carbon dioxide will be given off. This reaction absorbs heat and proceeds slowly because the lumps of limestone present a relatively small exposed surface. In order to hasten this reaction, a high bath temperature is essential. As the lime calcines it replaces the iron and manganese oxides and forms calcium silicates, sulphides and phosphates together with iron, manganese and aluminum oxides. This is a complex slag

**Figure 5 — Source and distribution of sulphur, 68 per cent hot metal.**

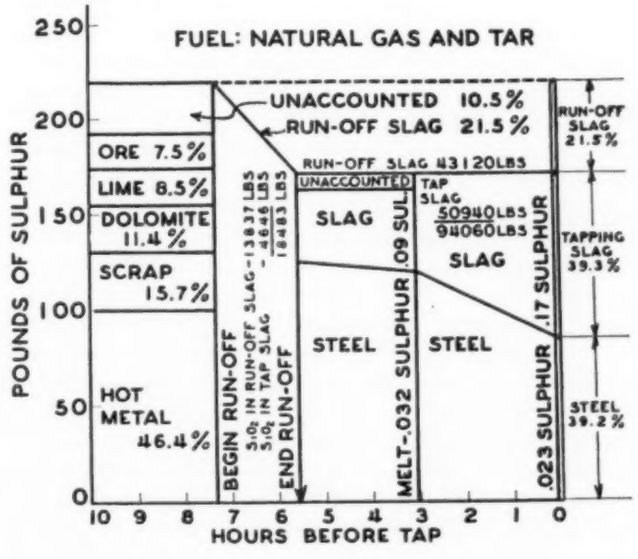
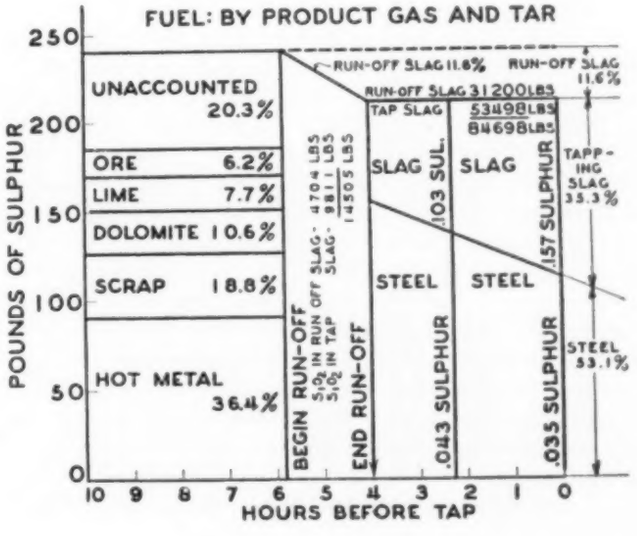



**Figure 6 — Source and distribution of sulphur, 66 per cent hot metal.**



and requires a lime-silica ratio as high as possible in order to reduce the sulphur in the steel to a minimum.

On some heats, especially those on the cold side, the limestone calcination proceeds very slowly. To achieve rapid calcination of limestone, a bath temperature of close to 3000 F at the start of the lime boil should be the aim of the furnace operator. Maximum flame temperature during the early run-off stage of the heat will promote an early and active reaction of the limestone. At this time the bath can be heated and the reaction speeded up by the use of an oxygen lance for a short time. Oxygen will combine with iron and quickly heat the bath to the point where the limestone is readily calcined and rapidly goes into solution, thereby forming the type of tap slag which absorbs and retains sulphur and conditions the heat for tapping. All open hearth shops should be equipped with oxygen so that carbon can be speedily reduced and sluggish heats stimulated and shortened.

## WORKING HEAT

The melt carbon is usually described as the carbon content of the bath at the time the calcination of the limestone is completed. The heat is then ready to be "worked." The aims of working are to oxidize the remaining phosphorus; to reduce the carbon to the desired level and if necessary to raise the temperature to that desired for tapping. It is desirable to have the bath at or above the tapping temperatures before starting to eliminate the carbon, since the melting point of steel rises as the carbon content decreases. Carbon reduction is achieved by the use of ore or oxygen or a combination of both. If a heat is hot, carbon can be reduced by the use of ore alone at a rate of 75 points per hour. It is difficult to furnish enough heat through the slag by fuel firing to effect the decomposition and solution of the resulting lime since the overall reaction requires heat; the bath itself should be hot enough to supply this heat. If however the bath is on the cold side, the use of oxygen at the same time ore is fed will furnish sufficient heat for the speedy reduction of carbon.

Many times it is apparent during the lime boil that the carbon content is considerably above the desired "melt." Heats can be speeded up by the simultaneous use of ore and oxygen so that at the end of the lime boil the desired carbon can be reached.

There is no advantage in having heats "melt" high above the specification limit since carbon reduction is a time-consuming operation and is not desirable metallurgically. High melt carbon with the introduction of large quantities of feed ore to reduce carbon adds considerable quantities of silica to the tap slag, increases the silica content of tap slag, and lowers the ability of tap slag to reduce sulphur from the bath. Some process control procedures in vogue in the industry require a melt carbon as much as 60 points above the specification limit, and many heats have been melted over 1.00 per cent carbon on an under 0.10 per cent carbon specification. Open hearth shops making the fastest heats endeavor to melt about 30 points above specification, that being sufficiently high to condition the slag and make the required furnace additions.

To make fast heats, early temperature, rapid and heavy flush, rapid lime boil, melt carbon 30 points above specification, and carbon reduction below 0.20 per cent, preferably with oxygen, are essential. Bath temperature measurements by thermocouples are rapidly being adopted as standard and will provide a method of more accurately determining the proper tapping temperature.

## TAPPING

Proper care of the tapping hole of an open hearth furnace is a "must." Careful alignment when piping, proper drainage, complete cleaning after each tap, careful sealing of runner joint and thorough drying of runners are all essential.

The development of the "jet tapper" has been conducive to the maintenance of proper alignment of tap hole and to speed of opening and uniformity in the tapping speed. More than 60 per cent of the open hearth shops of the industry are now using the jet tapping device either entirely or at least on some heats, and recent reports show from 85 to 95 per cent perfect tap. The results are so satisfactory that most shops will be so equipped as soon as the supply becomes adequate.

## FINISHING SLAGS

Earlier in the discussion the effect of run-off slag on tapping slag composition was discussed and curves were presented which showed the relation of the sulphur content in finished steel to the composition of the tap slag. The fastest heats are those with the smallest volume of tap slag, containing the lowest percentage of silica and the highest lime-silica ratio. When the maximum percentage of the silicon in the pig iron is removed in the flush slag, the limestone is not required for the production of calcium silicate and is available for combination with sulphur as calcium sulphate and the layer of finishing slag is a minimum. Also, in the later stages of the open hearth heat, an increase in temperature of the bath must be made by conduction through the slag which is a slow process.

## INSTRUMENTS AND CONTROLS

The gradual improvement in open hearth performance and production has been made possible by the development and application of instruments, and by the establishment of uniform melting methods through exact knowledge of what was going on in the furnace system as indicated and recorded by the instruments. Today a modern furnace instrument panel gives instant and complete information from which furnace control and adjustment can be made in the interest of most efficient operation.

It is now possible to establish definite period control, subject only to adjustment as visual indication of furnace conditions dictate, by which we can duplicate from heat to heat those cycles of operation which will produce quality steel at maximum rate. Fuel flow-air flow, total hourly Btu input, furnace pressure, and temperature conditions at critical positions in the system are all known and can be automatically controlled to best advantage. Methods of automatic reversal, instruments for rapid determination of bath composition, such as the carbometer and the spectroscope, make

maximum production speed attainable. As yet no commercially applicable method of continuously determining waste port gas analysis and of automatically regulating fuel and air flow to insure optimum temperature conditions have been developed. This type of control is available, but not perfected to the rugged status required for an operating instrument. The "prover" now in use at most shops gives an indication of correct combustion conditions but as yet cannot be used either continuously or as a means of regulation.

However, instrumentation is worse than useless unless maintained so that the indications and records are correct. The mere existence of a complete instrument panel is no assurance of good operation. Its indications must be correct and must be carefully followed by furnace crews if they are to be of service. The analysis of the recorded readings of the furnace instruments should be made by men who are proficient in the proper interpretation of the data and who can set up procedures for furnace operation from trends which will be apparent from such analysis. In the most efficient plant in the industry, all furnace records are carefully scanned by engineers who bring to the furnace melter and helpers the knowledge of conditions and set up procedures, which may well vary during a furnace campaign, for the most efficient operation of each furnace.

Correctness of instrument indications and recordings, intelligent use of this information and careful analysis of furnace records has contributed much to the attainment of maximum production records in the leading plants of the industry.

## CARE OF FURNACE

For fast heats, the open hearth furnace must be operated at maximum temperature. High firing rates mean fast melt down, early hot metal additions, fluid flush slag. The maintenance of high temperatures means rapid calcination of limestone and rapid carbon drop, but high temperatures require careful handling to prevent roof and wall erosion. High firing rates often uncover weakness of construction which were not apparent under lower firing rates. When these conditions present themselves, the temporary remedy is to build the vulnerable sections of the furnace of basic or high alumina brick. These changes are often temporary since they are made to remedy a weakness in design which can be eliminated during a complete rebuild, thereby reducing the need for the more expensive basic brick.

Maximum combustion conditions should be checked at various stages in the campaign of the furnace so that the maximum application of fuel will show a satisfactory condition in the exit port and thereby prevent damage to the fan tail arches and top of regenerators. The "prover" is a quick and convenient tool for checking combustion conditions.

The furnace system, particularly the portion under the floor, should be carefully sealed and periodically inspected to prevent air infiltration into the regenerator uptakes and port ends, Sealing of regenerator from the inside, especially the joints at fan tail arches, is important in reducing infiltration to a minimum.

Cleanliness of regenerators is of the highest importance if they are to operate efficiently; checkers should be inspected daily and blown regularly. Burners and ports receive periodic maintenance in the interest of maintaining proper flame direction.

## MAXIMUM AVAILABILITY

To secure maximum production, furnace availability should be high. In the newer shops 95 to 97 per cent availability is possible; whereas in some of the older shops 90 per cent availability is an excellent figure. Careful planning, proper scheduling and co-ordination of effort during rebuilding can increase availability by at least three per cent. Efficient and fast masonry work is important not only on rebuilds but also on all hot patch jobs.

## THE IDEAL HEAT

Having discussed the methods of maximum production, we now come to the end result—the ideal heat. Figure 7. A high hot metal charge is used on such a heat.

This ideal heat having a tap-to-tap time of 8 hr, 30 min, results from the most efficient operation of an open hearth furnace. This is not an unattainable goal. Some

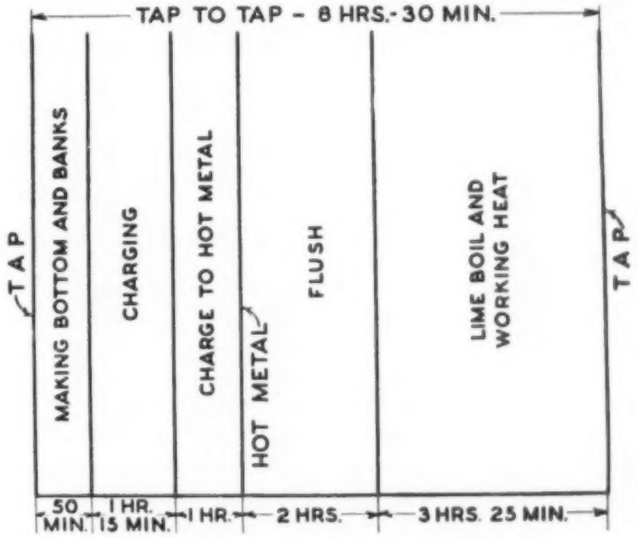



Figure 7 — Ideal open hearth heat.

heats will be made in a shorter time and others will require a longer time. Some heats will be over the ideal time, since the elimination of all charging delays and hot repairs represent a condition which cannot always be attained. Hot metal which contains from 1.60 to 2.00 per cent silicon is not uncommon when blast furnaces are being pushed for maximum tonnage. Heats will melt high in spite of the best efforts, and specifications for extremely low carbon are frequent in some shops. However, it is the 11, 12 and 13 hr heats which raise the average tap-to-tap time and cut down production. The heats over 12 hr are usually those with hot patch work, and with careful planning can be reduced to one heat per day in each shop. In closing, we should pay tribute to the open hearth operating personnel who have contributed so handsomely to the increase in production attained in the shops of the industry in response to defense needs during the past 18 months.

# Code Interpretations

# AND CONDUCTOR SELECTION FOR CRANES AND HOISTS

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Shepard Niles Crane & Hoist Corp.
Montour Falls, N. Y.

*. . . . paper presented at 4th Biennial Materials Handling Conference, sponsored by Westinghouse Electric Corp., at Buffalo, N.Y., October 28 and 29, 1952 . . . . this subject is of particular interest to the AISE, as the AISE Wiring Committee is now working with the appropriate National Electric Code committees in an attempt to obtain revisions of the crane wiring specifications of the N.E.C. . . . . AISE views on proper requirements are outlined in AISE Standard No. 8 (October 2, 1949)—Crane Wiring Standards . . . .*

▲ IN the early days of wiring cranes and hoists, the practice was much the same as wiring houses. The conductors were run open, mounted on cleats, or run through loom. Sizes were determined by past experience. The conductors were run about the crane or hoist wherever it was most convenient and direct.

As time went on, improvements in the method of wiring were adopted. Raceways and conduits were developed so that today all conductor wires about a crane or hoist are fully enclosed and protected from mechanical injury, which also eliminates fire hazards.

Tables giving current carrying capacity of conductors were developed and adopted. Rules governing the sizes to be used were worked out. Finally, codes were developed governing electrical installations. Naturally, these were not perfect and a hardship was many times created unnecessarily. However, as time went on, these conditions were remedied to a great extent, but even today there may be cases where the requirement of conductor sizes may not be just. As a matter of fact, I believe that the manufacturers of electric cranes and hoists still feel that the sizes of conductor required are larger than experience dictates.

The supervision of electrical installations through a code goes back over fifty years to October 19, 1881, when a standard for electric light wires, lamps, etc., was issued by the New York Board of Fire Underwriters. On May 12, 1882, the National Board of Fire Underwriters of New York adopted the rules of the New York Board and in the following month the Boston Board of Fire Underwriters issued similar rules.

In the years following, many efforts were made to bring uniformity in the rules. In 1895, in a further effort to obtain uniformity between the rules issued by the Underwriters' organization and those issued by the National Electric Light Association, a conference committee was appointed, on which a number of national societies were represented. In 1897 this committee issued a set of rules under the title, National Electrical Code, and this title has continued to the present time.

The wiring of present day cranes is much more complicated than it was 40 or 50 years ago. With all of the modern accessories of a present day crane, the wiring of control panels, etc., becomes more of a problem. When looking at the back of a control panel of a modern crane, one is reminded of the back of a television set, only on a larger scale.

To review some of the progress made along the line, let us go back to the year 1930. In 1930 National Electrical Code made no provision for a common return in wiring, as was the practice of crane builders. Wire was provided for contact conductors only, and many other provisions that the present day code specifies were not mentioned.

In the fall of 1930, the Electric Overhead Crane Institute was requested by the National Electrical Code authorities to have representatives at the 1930 November meeting of Article 30 Committee for the purpose of revising the code. (Article 30 Committee covered cranes and hoists of the National Electrical Code.)

Mr. Henry Schramm and myself were appointed as the Crane Institute representatives. We attended the Article 30 Committee meeting held November 18, 1930, and recommended certain changes to the code, among which were a change in the size of conductors required, a common return wire, and other shapes as well as wire for contact conductors. Other shapes suggested were steel tees, angles, tee-rails, or other stiff shapes. A common return wire was adopted for the 1931 edition.

The matter of smaller size conductors for crane and hoist wiring was not successful. Certain tables for conductor capacity were presented, based on years of experience, but this was not enough. The subject was placed back in the laps of the crane manufacturers to present proof by tests. It was admitted that the conductor sizes required were too large, but we had to give proof of required size before any change would be granted.

At the same time, the matter was referred to Article 8 Committee for consideration.

Article 8 Committee did change the percentage of motor nameplate readings to determine the amperage to be used in fixing the size of conductors required by reducing the percentage. The table giving carrying capacity of conductors was not changed. This helped, to some extent, to clarify the size of conductors required.

After the November 1930 meeting, no material change was made in conductor sizes required until about the year 1940. Control circuits, such as conductor to push button smaller than No. 12, were not permitted until the 1933 edition. The 1933 code permitted No. 14 size conductor.

To show how conservative the 1930 table regarding conductor sizes was, the following test on two sizes of conductor, which was conducted by one of the crane manufacturers, is given as follows:

A-C Motor
3-hp, 60-cycle, 440-volt
Full load speed 1140 rpm
Rating—30 minutes 55 C
Hoist motion —Size wire No. 8
Temperature motor—Start 22 C
Finish 60 C 38 C rise
Temperature wire —Start 22 C
Finish 27 C 5 C rise
Amperes —Up—Start 40 run 30
Amperes —Down—Start 20 run 12
Number trips—24

The 1930 Code would have required No. 6 size conductor, which is larger than above.

The 1951 Code would require No. 10 size, which is smaller than above.

D-C Crane motor
515 rpm
24-hp, 220-volt
96 Amperes—Name plate
Rating—30 minutes 55C
Hoist motion —Size wire No. 4
Temperature motor—Start 21 C
Finish 65 C 44 C rise
Temperature wire —Start 21 C
Finish 28 C 7 C rise
Amperes —Up—start 90 run 70
Amperes —Down—start 55 run 35
Number trips—28

The 1930 Code would have required No. 0 size conductor, which is larger than above.

The 1951 Code would require No. 2 size, which is larger than above.

The above tests show that the conductor sizes could be smaller than the latest code permits.

In the 1940 edition of the National Electrical Code, the allowable carrying capacities of conductors were reduced considerably in some of the larger sizes, again adding a burden to the crane builders. However, in 1942, due to the war effort and critical materials, it was voted to use the 1937 Code for determining size of conductors to be used during the period of the war.

No effort had been made by the crane and hoist manufacturers after 1930 to get the required sizes of conductors to be used for crane and hoist wiring revised until the revision of the 1940 Code.

In March 1942 there was a meeting of Article 610 Committee, formerly known as Article 30, to consider the revision of the 1940 Code for the 1943 edition.

Prior to this meeting, it was learned that the Canadian Engineering Standards Association had a Code known as C.E.S.A. Specification C22.2, No. 33, 1936, governing the construction and test of electric cranes and hoists.

In these specifications was a table giving the current carrying capacity for half-hour rated crane motors, starting with No. 12 conductor to 0000 conductor.

It appeared that if the Canadian authorities saw fit to develop a table giving capacity of conductors for crane and hoist wiring, then the National Electrical Code might also have such a table.

At the 610 Committee meeting held on March 9, 1942, the Canadian table and many other suggestions were presented to the committee for adoption. Among some of the other suggestions was a request that No. 16 conductor be added to the table for small cranes and hoists. Also that No. 16 conductor be permitted for control circuits.

The committee was of the opinion that since the Canadian authorities had adopted such a table that we also could go along. Therefore, the Canadian table was adopted and No. 16 conductor was added and also No. 16 was voted for control circuits. The requirement for No. 16 conductor was that it be mechanically protected.

During the deliberations of the various Article Committee Meetings, it was voted not to print a 1943 edition due to the war and shortage of paper.

Any recommendations adopted for the 1943 edition which would conserve critical material were later adopted by the Electrical Committee and made a supplement to the 1940 Code. Since the table for current carrying capacity of conductors for cranes and hoists would require smaller conductors and, therefore, conserve critical material, it was adopted and added to the 1940 supplement.

By Interim Amendment No. 61 dated July 11, 1942,

**TABLE I**

**For A-C Cranes**
**3-Phase A-C Motors, Squirrel Cage and**
**Wound Rotor-Induction Type 220 V.**

| Motor hp | Motor amperes | Conductor sizes required | | | | |
|---|---|---|---|---|---|---|
| | | Based on 110 per cent of motor name plate reading. 1930 Code | Based on 90 per cent of motor name plate reading. 1931-1933 1937 Codes | Based on 90 per cent of motor name plate reading. 1940 Code | Based on 90 per cent of motor name plate reading. 1947-1949 1951 Codes | Article 610 cranes and hoists 1947-1949 1951 Codes |
| ¾ | 2.8 | 12 | 12 | 12 | 14 | 16 |
| 2 | 6.5 | 12 | 12 | 12 | 14 | 14 |
| 3 | 9 | 12 | 12 | 12 | 14 | 14 |
| 7½ | 22 | 10 | 12 | 12 | 12 | 12 |
| 10 | 27 | 8 | 10 | 10 | 10 | 10 |
| 20 | 52 | 4 | 6 | 5 | 6 | 6 |
| 30 | 78 | 2 | 4 | 2 | 4 | 3 |
| 50 | 125 | 00 | 0 | 00 | 0 | 1 |
| 75 | 185 | 0,000 | 000 | 250,000 | 0,000 | 00 |
| 100 | 246 | 300,000 | 0,000 | 400,000 | 300,000 | 0,000 |
| 150 | 360 | 500,000 | 400,000 | 750,000 | 600,000 | 300,000 |
| 200 | 480 | 800,000 | 600,000 | 1,500,000 | 900,000 | 400,000 |

the table for current carrying capacity of conductors for cranes and hoists became effective.

In November 1944, Article 610 Committee, along with other article committees, convened for the purpose of again revising the 1940 Code for the 1946 edition, which really became the 1947 edition, the first after the war.

All of the suggested changes including the table of conductors for cranes and hoists which had been adopted in 1942 had to be re-submitted.

Fortunately, these wires adopted by the article committee and approved by the electrical committee became a part of the 1947 Code. The 1949 Code and 1951 Code contained these changes in Article 610 (Cranes and Hoists). See Tables I and II.

In Tables I and II, the capacity of conductors was taken for the following types of conductors:

1930, 1931, 1933, 1937 Codes—Rubber insulated.
1940 Code—Rubber type RW, R.
1947 Code—Rubber type R, RW, RU (14-6). Thermoplastic type T (14-4), TW (14-4/0).
1949 Code—Rubber type R, RW, RU (14-2). Thermoplastic type T (14-4/0) TW (14-4/0).
1951 Code—Rubber type R, RU, RUW (14-2). Thermoplastic type T, TW.

The 1940, 1947, 1949 and 1951 N.E. Codes, Table I—Allowable current-carrying capacities of insulated conductors in amperes, states: Not more than three conductors in raceway or cable. The codes specify that for 4 to 6 conductors, the carrying capacities as given in Table I shall be reduced to 80 per cent and for 7 to 9 conductors, reduced to 70 per cent.

The table of current-carrying capacity of conductors as given in the table under Article 610 (Cranes & Hoists) does not have any such restrictions on the number of conductors in raceway or cable. Therefore, there would be a greater saving in conductor sizes in case of more than 3 conductors for cranes and hoists than shown in the above tables.

The above tables are for general wiring and do not consider secondary circuit nor places where other types of conductor are required such as conductors to resistance, etc.

Above is as the layman would view the matter. Anyone making a special study of the subject by searching every nook and corner of the codes might find some difference in the results as given here.

In these times of rush, one does not always have the time to make a thorough search and minute examination. Some manufacturers might have a large staff with individuals whose sole duty would be to make a study of all matters pertaining to code requirements, while others may not be in a position to do this and must depend more or less on superficial study.

If the crane and hoist manufacturers could in some way find some one who could make a study of the electrical code and pick out those items which effect cranes and hoists and then print a booklet containing just the rules that are effective, it would save considerable time and prevent many headaches. Each edition of N. E. Code would require a review in order to keep us up-to-date.

The Electrical Safety Orders of the State of California, as revised in February 1951, adopted the same tables and types of conductors for wiring cranes and hoists as the National Electrical Code.

Another matter which for the past few years has given crane and hoist manufacturers a headache has been the installation of contact conductors, especially in California. There had been in use in California a set of Electrical Safety Orders effective May 1, 1934 and issued by what was then known as the Industrial Accident Commission of California. These safety orders contained a section covering cranes and hoists, and in this section were orders governing the installation of what is now known as contact conductors.

No trouble had been encountered regarding the contact conductors until about 1945, when those in charge began to place some very tough interpretations on the orders.

I have a copy of a letter by the State of California, Department of Industrial Relations, Division of Industrial Safety, State Building, Los Angeles 12, dated March 28, 1945, and addressed to a California company. It is in regard to an order requiring the California company's guarding of all crane contact conductors. The letter quotes the code regarding contact conductors and ends up by stating, "by effectively guarded" is meant that they are to be enclosed or guarded on all sides.

From various sources reports had come to the attention of the members of the Crane Institute and Hoist Association regarding the situation. In 1946 the Monorail Manufacturers Association, the Crane Institute, and the Hoist Association appointed committees from each to take the matter under consideration and draw up a brief and file same with the California authorities. The committees met in February 1946 in a joint session, and a brief was drawn up and filed with the Chief of Division, Division of Industrial Safety, State of California, in March 1946.

The following brief was written some six years ago, and during recent years there have come on the market heavier duty enclosed contact conductor systems having higher carrying capacity. Of course, this will offset some of the points contained in the brief regarding capacity, but they still fall short of the possible requirements. Any code making it mandatory that enclosed conductors be used would seem to be out of place. The brief is as follows:

1. The interpretation of Art. 30, Crane and Hoists Order 7-3004-d, size and location of collector wires of the Electrical Safety Order of the Industrial Accident Commission, State of California, by the Division of Industrial Safety, Department of Industrial Relations, to the extent that all contact conductors for main crane runway or bridge trolley conductors be enclosed rather than protected by isolation or effectively guarding, has been received by manufacturers as represented by the Electrical Overhead Crane Institute, the Electric Hoist Manufacturers Association and the Monorail Manufacturers Association with considerable concern.
2. These industries have been ever mindful of the necessity of safety precaution for life and limb in the design, operation and maintenance of these products, and have consistently cooperated to this end by working with the National Electrical Code, the National Electrical Safety Code, the American Standard Association, and the various State Industrial Safety Commissions in promulgating safety orders for the installation and operation of Electric Overhead Crane, Electric Hoist and Monorail equipment, having permanent member representations in the pertinent section of the National Electrical Code and the American Standard Association.
3. Overhead Material Handling Equipment has become an economic necessity in industrial manufacturing and processing, built in a very wide range of assembled form to suit an extremely wide service range and demand in its ability to handle

**TABLE II**

**Allowable Current Carrying Capacities of Insulated Conductors in Amperes**

| Size AWG MCM | 1930 Code | 1931 1933 1937 Codes | 1940 Code | 1947 1949 1951 Codes | Article 610 cranes and hoists, 1947-1949 1951 Codes |
|---|---|---|---|---|---|
| 16 | 6 | 6* | ... | ... | 10 |
| 12 | 20 | 20 | 20 | 20 | 25 |
| 8 | 35 | 35 | 35 | 40 | 45 |
| 4 | 70 | 70 | 60 | 70 | 77 |
| 2 | 90 | 90 | 80 | 95 | 107 |
| 0 | 125 | 125 | 105 | 125 | 160 |
| 0,000 | 225 | 225 | 160 | 195 | 300 |
| 300,000 | 275 | 275 | 198 | 240 | 410 |
| 500,000 | 400 | 400 | 265 | 320 | 620 |
| 750,000 | ... | 525 | 330 | 400 | ... |
| 900,000 | 600 | 600 | 360 | 435 | ... |
| 1,500,000 | 850 | 850 | 434 | 520 | ... |

*In flexible cord capacity = 7 amp

safely heavy loads and perform a continuity of operational output. It is a recognized fact that in the more advanced industrial communities that the use of Overhead Material Handling Equipment such as cranes and hoists contributes not only to increased productive capacity of the worker, but also eliminates drudgery and heavy work and contributes directly to worker's health and safety by reduction of the hazard of strain and rupture. This is shown clearly in plant records where determined efforts have been made to reduce these hazards by the introduction of Material Handling Equipment of modern design.

4. Elements which add unduly to cost tend to make certain installations economically unsound with the result that the benefits of safety to workers contributed by equipment of this type is not realized if the equipment is not purchased and installed. This is particularly true in the smaller installations appearing in both large industries and also in small individual plants.
5. Certain details of design and operation of such equipment must, in addition to providing the necessary safety features, provide service performance and features for safe, easy and quick maintenance service of the functional elements of the equipment. Ready observation of wear and possibility of eventual failure so that preventive maintenance can be readily and safely performed is a requisite of design and must be given due consideration so that overall safety is not overlooked and balanced design in all respects is achieved.
6. The majority of these crane manufacturers each have about six or more conventional conductor and collector arrangements to supply current to the crane bridge, hoist or trolley, suitable for the various service demands of load, speed and atmospheric conditions.

These arrangements, consisting of one of the following:

7. (a) Supported copper or steel conductors with sliding shoe or wheel type collectors.
   (b) Supported steel conductor section, such as angles or T-bars with spring operated sliding contacts operating against the vertical area of the conductor.
   (c) Supported steel section conductors, such as bars, angles, or light section rails with gravity contacting collectors.
   (d) Supported inverted steel angle sections with spring or weight operated collectors contacting the inverted area.
   (e) Cable supply conductors operating from messenger wire.
   (f) Cable supply operated by spring or power operated take-up reels.
8. *Item (a)* is used generally on average capacity, average speed (up to 600 feet per minute) moderate duty cycle (10-20 full load lifts per hour), in clean, wet or dry atmospheres and where space factor is at a premium.
9. *Item (b)* is used frequently on constant duty cranes such as grab bucket in cement and fertilizer plants where the nature of the material is inclined to coat any horizontal surface and interfere with the proper surface contact for collectors.
10. *Item (c)* is almost universally used on constant or severe duty cranes of the higher capacities or higher speeds where the service demands on the conductor and collector equipment are severe and uninterrupted production necessary.
11. *Item (d)* is sometimes used in areas subject to frost, sleet, snow or ice to improve collector contact under these conditions.
12. *Item (e)* and *(f)* are occasionally used as might be demanded by hazardous atmospheric conditions or in handling combustible materials and where limited travel distance permits use of this type of power feed.
13. In addition partially enclosed contact conductor systems (trolley duct) are used with the lighter capacity, slow speed, units installed at low elevations where open conductors would present a hazard.
14. Attached cuts and photos are generally descriptive of the arrangement of collector and conductor systems. Capacity requirements on these conductor collectors will vary from a few horsepower to as high as 750 connected horsepower. This represents a current draw up to 3000 amperes. Trolley speeds will vary from 50 feet per minute to 400 feet per minute. For conductor and collector systems supported along the main crane runway many will have current capacity requirements up to 1000 amperes for standard hook cranes, and well above this figure for steel mill cranes. Crane bridge speeds of 500 fpm are common with top speed requirements of 750 to 1000 fpm on production cranes.
15. Atmospheric conditions vary from clean and dry conditions to very humid and highly acid or alkaline and dust laden atmospheres, as in pickle, galvanizing and chemical plant conditions.
16. The number of conductor and collector units required per crane bridge will vary from eight on a three motor cage controlled direct current crane up to forty on a seven motor powerhouse or steel mill crane.
17. Service duty demands are exceedingly varied in crane and monorail applications, ranging from six or seven full load lifts per year to approximately two full load lifts per hour for stand-by duty cranes and hoists such as powerhouse, motor rooms, etc., up to eighty full load lifts or better, per hour on severe duty service such as magnet handling, grab bucket handling, warehouse, stockyard, cranes and production lines. There are three additional intermediate duty cycle ratings that affect size and operating requirements.
18. We appreciate and commend an attitude of safety requirements governing the application of the above conductor and collector systems, but we do not believe any so called enclosed conductor unit as yet built will satisfy all of the requirements necessary for capacity, speed, space factor for the required number of conductors and the stability for service life and safe accessibility for maintenance. For conductors where unusual hazards of location exist, we believe that conductor collector systems now available as mentioned in 1 to 6 inclusive, can be properly and reasonably protected, guarded or shielded against accidental or unintentional contact by unauthorized persons. Further, we believe, and experience has shown, that "so called" complete shielding of contact conductors by no means eliminates all accidents due to unintentional contact with these conductors. In addition, it is our sincere belief that accidents will be increased if the contact conductors and collectors are made inaccessable for ready inspection and maintenance. As an additional safety precaution on all cab operated cranes equipped with a service platform, we recommend that a safety disconnect switch which can be independently locked open, be mounted on the crane platform. This allows any authorized person to maintain a dead bridge conductor system while he is working on or has access to the crane.
19. We believe main crane runway and most monorail systems are normally isolated by elevation and by location as to require no guarding. We believe it possible to design and install proper conductor guards for those installations where the above protection by isolation might be from the nature of the plant construction not entirely adequate for conservative safety protection and to meet exacting service demands. A bare exposed conductor is not necessarily an unusual hazard as evidenced by street railway and mine locomotive practice.
20. On existing installations we suggest a reasonable time for a practical solution of guarding be allowed to avoid work stoppage. We believe, until such time that a product has been developed to meet adequate carrying capacity, service life, necessary operating speed and space mounting factor of the full range of applications, the insistence on the use of the partially enclosed conductor or trolley duct systems would be a material hardship on crane users and detrimental to the maximum use of electric overhead equipment.
21. On monorail systems embodying track switches, crossovers, turntables, etc., and on crane systems incorporating the underslung transfer crane where loads are transferred from a crane to a fixed monorail or to another crane, the requirement that the current collectors successfully follow the contact conductor across or over the required conductor gap becomes of major importance. Equipment to meet this requirement must have long contact shoes or large diameter collector wheels to meet the practical requirements of successful operation without continual and excessive maintenance to hold to close and accurate alignment, both vertical and horizontal.
22. A further requirement of contact conductors for monorail systems is that of flexibility. Curves in the tract system are a constant and regular requirement and if contact conductor curve costs are excessive, then industrial workers will be denied the use and advantages of modern material handling equipment in many cases since such installations will become economically unsound.

23. As now available enclosed contact conductor systems are from 100 per cent to 400 per cent higher in cost than conventional electrification systems. This by no means should be taken in itself to indicate that enclosed contact conductor systems should not be used but it does raise the question as to whether or not this is the wisest expenditure possible from which to obtain a maximum of increased protection to workmen or as to whether or not they should be a universal requirement when experience has shown that *except in truly hazardous locations*, exposed conductors have not contributed unduly to industrial accidents—certainly not as much as the ordinary stairway which also could be eliminated.
24. At best all designs are a compromise with a reasonable balance between elements entering into the design. When undue emphasis is placed on the importance of a single element, it follows naturally that other elements suffer. In this particular instance we feel that if undue emphasis is placed upon conductor enclosure to avoid accidental contact that the elements of accessibility and safety for maintenance, ease of regular inspection to determine where and avoid failure, the extent of the use and application of this labor saving equipment; all will suffer to the extent that accidents both electrical and physical will actually be increased farther than decreased.
25. We believe industrial rules should allow only qualified persons access to electrified overhead material handling equipment for adjusting, testing or maintenance work and allow no other persons access unless the power circuit is disconnected and locked open from its power source.
26. We recommend that the California Code be modified or interpreted to conform to the adopted wording by Article 610 Electrical Committee for the National Electrical Code, October 1945, in Chicago.

To wit:

ISOLATING OR GUARDING CONTACT CONDUCTORS. Except in locations to which only qualified persons are admitted, contact conductors shall be so isolated by elevation or be provided with suitable guards so arranged that persons cannot inadvertently touch the current carrying parts while in contact with the ground or with conducting material connected to the ground.

*Definitions*

QUALIFIED PERSON as per National Electrical Code 1940 Page 15.

One familiar with the construction and operation of the apparatus and the hazards involved.

ISOLATED as per National Electrical Code 1940 Page 13.

Not readily accessible to persons unless special means for access are used.

GUARDED as per National Electrical Code 1940 Page 13.

Covered, shielded, fenced, enclosed, or otherwise protected, by means of suitable covers or casings, barriers, rails or screens, mats, or platforms, to remove the liability of dangerous contact or approach by persons or objects to a point of danger.

The reaction to this brief by California was not very encouraging.

But as time passed, the situation eased up to some extent until the California authorities could rewrite their 1934 Electrical Safety Orders. In May, 1947, the Division of Industrial Safety of California held committee meetings in Los Angeles and later in San Francisco to consider the revision of the 1934 edition.

I was appointed by the Electric Overhead Crane Institute and the Electric Hoist Manufacturers Association to represent them at these meetings. Later I filed in writing the suggestions and comments which I gave the Committee Meeting.

There were a number of items on which suggestions and comments were given besides the matter of contact conductors. Most all of the suggested changes were accepted except the one on contact conductors.

In the proposed orders, which were the product of the committee meetings, the order concerning installation of contact conductors was very much more rigid and positive than was the rule in the 1934 edition.

In January 1950, public hearings were held on the proposed orders and I attended these meetings and again presented the same objections to the orders and gave suggestions for consideration.

When a copy of the proposed Electrical Safety Orders was received, which copy was a result of the public hearings, it was found that the same stand was taken regarding the installation of contact conductors.

The order read as follows:

2489. Installation of Contact Conductors. (a) Bare Conductors. All bare ungrounded contact conductors installed after these orders become effective shall be effectively guarded by enclosures of suitable material or approved devices so that persons may not come into contact with them.

The balance of the order refers to contact conductors outside of the building, which I will not quote.

Take note of the statement, "effectively guarded by enclosures of suitable material." No consideration was given to isolation by elevation.

**TABLE III**

**Dimensions of Rubber-Covered and Thermoplastic-Covered Conductors**

| Size AWG MCM | Types RF-32, R RH, RW | Types TF, T, TW RU, **RUF, RUW | Bare conductors |
|---|---|---|---|
| | Approximate diam, in. | Approximate diam, in. | Diam, in. |
| 16 | 0.158 | 0.118 | 0.0508 |
| 12 | 0.188<br>0.221* | 0.148 | 0.0808 |
| 8 | 0.311 | 0.228 | 0.1285 |
| 4 | 0.452 | 0.372 | 0.232 |
| 2 | 0.513 | 0.433 | 0.292 |
| 0 | 0.629 | 0.549 | 0.373 |
| 0,000 | 0.785 | 0.705 | 0.528 |
| 300,000 | 0.933 | 0.843 | 0.630 |
| 500,000 | 1.119 | 1.029 | 0.814 |
| 750,000 | 1.339 | 1.249 | 0.998 |
| 900,000 | 1.435 | 1.345 | 1.093 |
| 1,500,000 | 1.801 | 1.702 | 1.412 |

*Type RW; **No. 14 to No. 2; No. 18 to No. 8 solid: No. 6 and larger stranded.

We still had one more chance as we were given the opportunity of filing any comments we might have with the Industrial Safety Board. A copy of comments which was given at the public hearings was filed with the Board and on receipt of the final code which became effective as revised February 26, 1951, it was found that some modification was made. At least this is my opinion.

The order now reads:

2489. Installation of contact conductors. (a) Bare Conductors. All bare ungrounded contact conductors installed after these orders become effective shall be

TABLE IV

A-C Motors, Squirrel Cage and Wound Rotor Motors, Amperes and Amperes to be used in Selecting Conductor Sizes

| Motor hp | Motor amp | Motor amp X 110 per cent | Motor amp X 90 per cent | Article 610 cranes and hoists, motor amp X 100 per cent |
|---|---|---|---|---|
| ¾ | 2.8 | 3.08 | 2.52 | 2.8 |
| 2 | 6.5 | 7.15 | 5.85 | 6.5 |
| 3 | 9 | 9.9 | 8.1 | 9 |
| 7½ | 22 | 24.2 | 19.8 | 22 |
| 10 | 27 | 29.7 | 24.3 | 27 |
| 20 | 52 | 57.2 | 46.8 | 52 |
| 30 | 78 | 86 | 70.7 | 78 |
| 50 | 125 | 137.5 | 112.5 | 125 |
| 75 | 185 | 203.5 | 166.5 | 185 |
| 100 | 246 | 270 | 221.5 | 246 |
| 150 | 360 | 396 | 324 | 360 |
| 200 | 480 | 528 | 432 | 480 |

effectively isolated or effectively guarded by barriers or by enclosures of suitable material or approved devices so that persons may not come into accidental contact with them or bring conducting material into contact with them.

No person other than a qualified electrician shall be permitted in the overhead of building where personal danger exists because of energized bare contact conductors, unless the switch controlling all energized bare conductors is locked in the open position. Balance of order refers to contact conductors outside of buildings.

The National Electrical Code regarding contact conductors reads as follows:

Section 6121 (h) Isolating or guarding contact conductors. Except in locations to which only qualified persons are admitted, contact conductors shall be so isolated by elevation or be provided with suitable guards so arranged that persons cannot inadvertently touch the current-carrying parts while in contact with the ground or with conducting material connected to the ground.

The definitions of both "qualified person" and "isolated" are the same in the California orders and National Electrical Code.

An endeavor was made to get California to adopt the National Electrical Code; either the entire code or the section pertaining to contact conductors. They did not, however, seem so inclined.

In my opinion the rules as they now stand are very much the same, and I cannot predict as to what interpretations may be placed on them.

There were many others working on this subject who had the same opinion as those of the Crane Institute and Hoist Association members. The Metal Trades Manufacturers Association of Southern California was one organization that did a great deal in this matter. So any modifications, if there are any, were as much due to their activities as those of anyone else.


*Plan to Attend*

**1953**

**AISE SPRING CONFERENCE**

**HOTEL STATLER**

**BUFFALO, NEW YORK**

**MAY 18, 19**

**AND**

**1953 ANNUAL CONVENTION**

**HOTEL WILLIAM PENN**

**PITTSBURGH, PA.**

**SEPTEMBER 28, 29, 30, OCTOBER 1**

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"Control is fully automatic for utmost efficiency"

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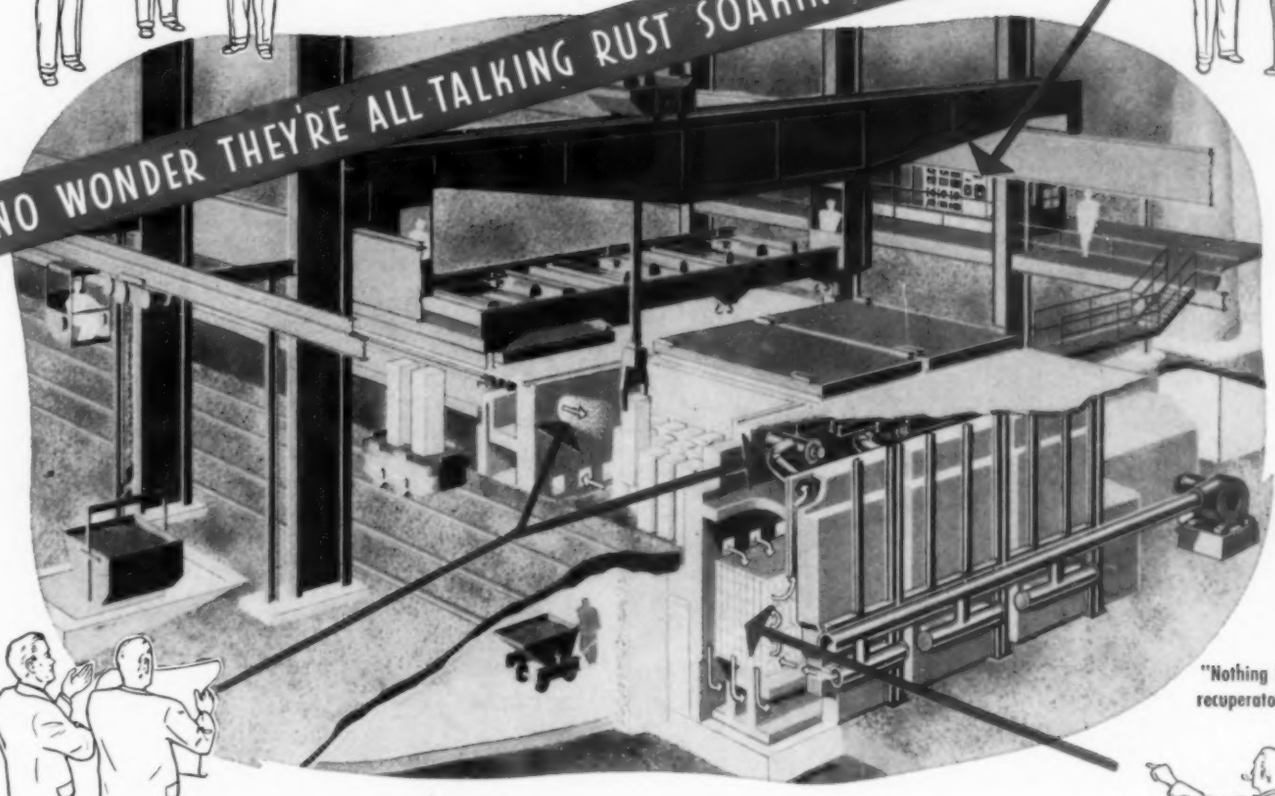

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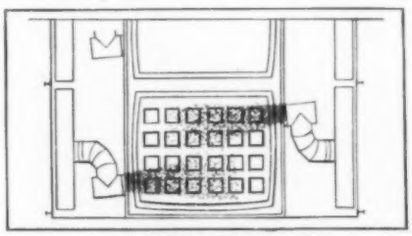
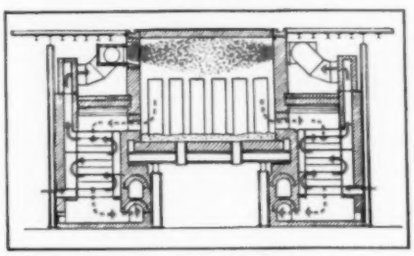


PLAN VIEW



CROSS SECTION

Naturally, furnace men are impressed with the improvements provided by Rust's new ultra modern recuperative soaking pits. Heat is uniformly balanced by diagonal two-way firing and ingots soak out evenly. Absence of impingement increases life of refractory walls and covers. Design permits construction in batteries of two or more holes, use of all fuels.

Rust also builds regenerative type soaking pits of new modern design. Those now in operation are producing results in fuel economy and heating speed never before achieved.

Whether you are interested in new recuperative or regenerative soaking pits, or require a modernization job you can rely on Rust. Over a quarter-century of experience is your guarantee.

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One contract covers everything . . . from blue-print through start up. Rust assumes responsibility for design, manufacture, erection, and is prepared to undertake all phases of the work with its own forces, including wiring and piping. This results in substantial savings . . . One profit instead of pyramiding ones which accrue where many subs are employed.

## RUST FURNACE COMPANY

*Pioneers in Furnace Design*

PITTSBURGH - PENNSYLVANIA

F-5

# HANDLING AND RECLAIMING MILL SCALE

*. . . . in one steel plant, 97 per cent of the mill scale from a hot strip mill is recovered by means of concentrators . . . .*

▲ A means of recovering 97 per cent of the mill scale from its hot strip mill has been developed by a midwestern steel mill. Three tons are recovered each hour the hot strip mill is in operation and an average of 950,000 lb are reclaimed each week, compared with 500,000 lb by the method previously used.

Since this mill scale is 72 per cent pure iron, each ton is equivalent to one and one-half tons of ore. Besides the substantial amount of iron recovered daily, the new system eliminates the problem of clogged sewers and is a major contribution in the fight against stream pollution. The mill scale concentrator which recovers this iron consists of three Link-Belt straightline sludge collectors, together with a horizontal belt conveyor and an inclined pivoting belt conveyor for loading the reclaimed mill scale into open railroad cars.

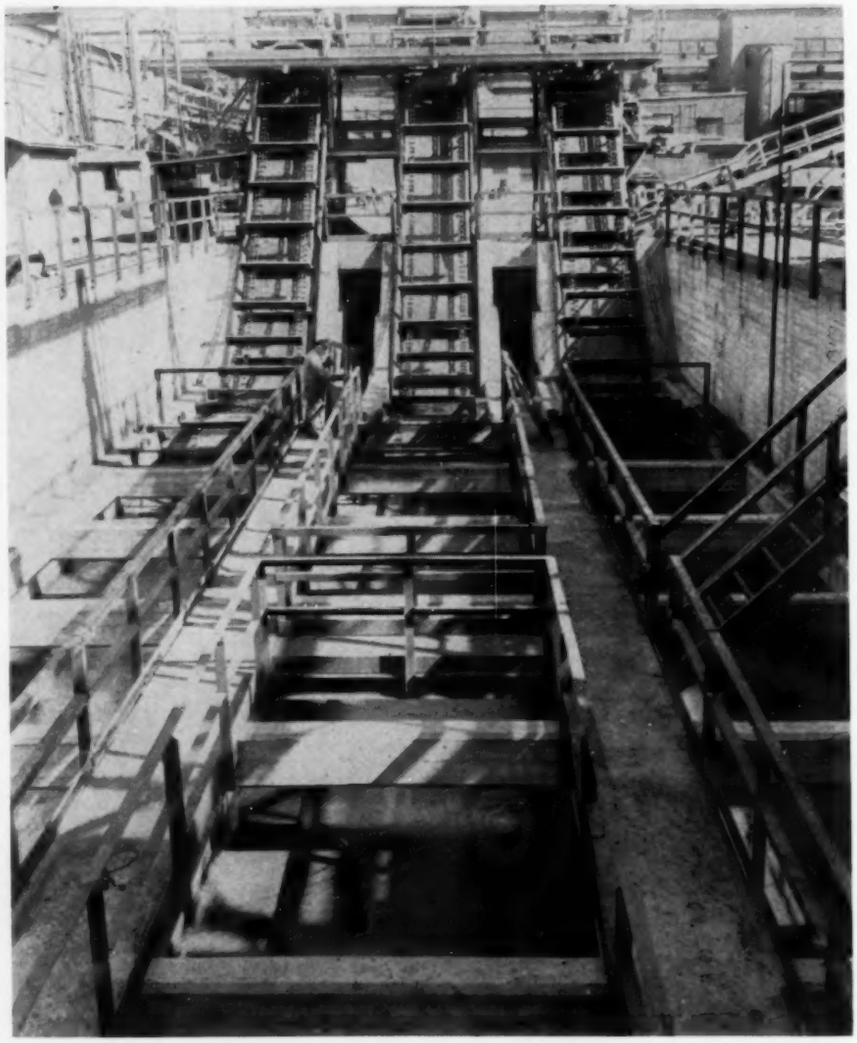


**Figure 2 — The mill scale and water flow into a concentrator with three sludge collectors which convey the scale out of the concentrator onto a belt conveyor.**

### MILLIONS OF TINY FLAKES

The intense heat of the steel as it passes through modern hot strip mills causes oxides to form on the surface of the steel. These oxides, better known as mill scale, are knocked off by high-pressure sprays of water as the strip emerges from each of six roughing mills. Each sheet of steel has millions of these flakes, varying in size from about a nickel to smaller than finely ground coffee. In the past, much of this mill scale went down the drain, despite attempts to reclaim it by diverting the water into sludge pits. The scale was then removed by bucket cranes — but only about 50

**Figure 1 — Mill scale is knocked off the steel strip by powerful streams of water as the strip emerges from the roughing mill. This water with scale flows in trenches to the concentrator.**

per cent of the scale was ever recovered by this method. The remainder passed into the sewers, causing frequent clogging.

Now the scale flows through covered trenches from the hot strip mill into the concentrator, where it settles to the bottom. Three Link-Belt straightline collectors travel along the bottom of the concentrator tank to collect the scale, dewater it and convey it up an incline, discharging it onto a horizontal collecting belt conveyor, then onto an inclined belt conveyor into a waiting railroad car. From here the scale is taken to the sintering plant for fusing into larger sizes before being charged into blast furnaces.

### NO CLOGGING OF SEWERS

Water coming into the concentrator contains about 3000 ppm of suspended solids, and the outgoing water has only about 40 to 50 ppm, with 7 to 10 parts iron. Since the river water averages 103 ppm of suspended solids, the water discharged from the mill is cleaner than that obtained from the river originally. Sewers are no longer clogged with this valuable iron.

The three concrete concentrator tanks are each 10 ft wide at the top, 5 ft wide at the bottom, with a water depth of 9 ft-6 in. and a total depth of 21 ft from operating floor to tank bottom. The tanks are 69 ft long, with an inclined discharge end.

Each of the three collector mechanisms consists of two parallel strands of Link-Belt C-110 combination promal and steel chain, with channel steel flights at 4-ft intervals. These flights have abrasion-resistant wearing flats. Each collector mechanism is powered by an electric motor through a flexible coupling, Link-Belt worm gear reduction and Link-Belt SS-88 roller chain drive. The head of the collector is supported on a structural steel frame. The inclined trough from the operating floor of the tank has 10-in. channel sides and ¼-in. liner plates.

The discharge chute with flap gate can divert the mill scale to the belt conveyor or to containers. A pivoted, counterweighted steel wiper at the head of the collector cleans the flights.

### SYSTEM LOADS RAILROAD CARS

Mill scale is discharged from the three collectors onto a Link-Belt flat horizontal belt conveyor which runs across the head end of the tank. The belt is 16 in. wide on about 34-ft centers. It operates at about 25 fpm. The conveyor head shaft is driven by an electric motor through a flexible coupling, Link-Belt worm gear reduction and Link-Belt precision steel roller chain. This belt conveyor discharges the mill scale into the loading hopper of an inclined, pivoted belt conveyor which delivers it to railroad cars. This conveyor is 16 in. wide and about 39 ft long, inclined 18 degrees.

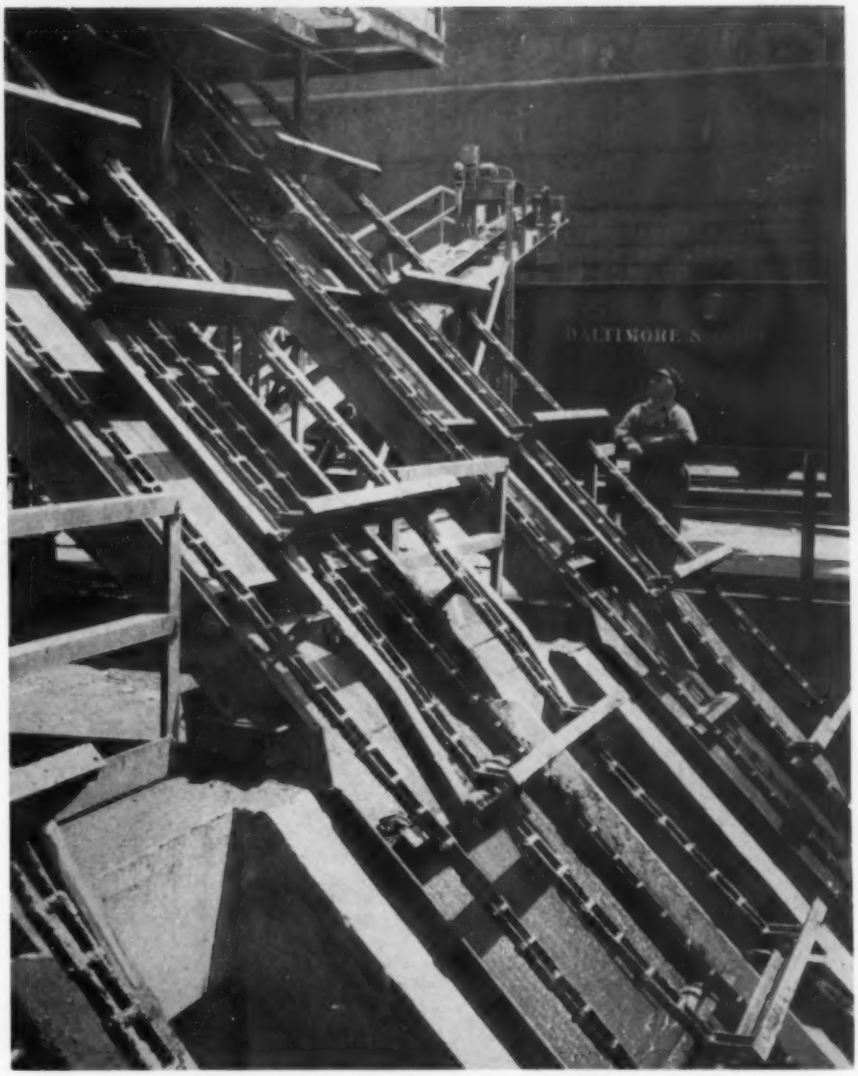


**Figure 3 — Close-up view of sludge collectors as they emerge from concentrator. In background is the inclined belt conveyor which delivers mill scale to railroad cars. This conveyor pivots in an arc of about 90 degrees.**

### SECOND CONVEYOR IS PIVOTED

One end of the structural steel support is pivoted, and the other end is carried on two 12-in. diam car wheels. The conveyor can travel on rails in an arc of about 90 degrees—This permits it to carry the mill scale directly to railroad cars alongside the concentrator and yet be moved out of the way for railroad clearance when not in use. Like the horizontal belt conveyor, the inclined belt conveyor is powered by an electric motor through a flexible coupling, worm gear reduction and roller chain drive. A hand-operated Rotoline skimmer is installed at the effluent end of the tank to remove oil from the water surface.

This system, in operation for a year, has reclaimed considerably more mill scale than originally contemplated. Hence this method not only has solved a difficult handling and disposal problem, but it has paid its way through its recovery of valuable material.

**GEORGE D. BRENGELMAN**
BIRMINGHAM DISTRICT SECTION

**OSBORNE K. SHARP**
BUFFALO DISTRICT SECTION

**CHARLES E. HOMER**
CHICAGO DISTRICT SECTION

# AISE DISTRICT CHAIRMEN 1952-1953

GEORGE D. BRENGELMAN was born in Nashville, Tenn. He received an engineering degree at Vanderbilt University in 1937, and after graduation was employed by the Tennessee Coal, Iron & Railroad Division, U. S. Steel Co., as a student engineer in the mills department of Ensley works. He served as practiceman, foreman mills service, assistant master mechanic and assistant department superintendent. In February 1950, he was promoted to assistant to the general superintendent. In May 1952 he was promoted to assistant general superintendent of Ensley works which position he now holds.

OSBORNE K. SHARP was born in Buffalo, N. Y. Since his graduation from the University of Kentucky in 1932, where he received a degree in metallurgical engineering, he has been with Republic Steel Corp.'s Buffalo plant. After serving in the metallurgical department at Republic, he was promoted to blooming and billet mill superintendent and has served in that capacity from 1942 until the present time. He is one of the charter members of the Buffalo chapter of AISE.

CHARLES E. HOMER was born in Provo, Utah. After attending the University in Provo and graduating from Bliss Electrical in 1925, he was employed at the Gary works of National Tube Co. and advanced to the position of foreman of electrical testing. In 1929, he joined the Youngstown Sheet & Tube Co. and through the years advanced to a number of positions which included electrical construction foreman, assistant electrical superintendent, electrical superintendent and is now superintendent of maintenance and power, Indiana Harbor works, East Chicago, Ind.

WALTER V. MAGEE is a native of Zanesville, Ohio. He interrupted his education in engineering at Ohio State University and joined the Army during World War I. He returned to Ohio State after the war and specialized in mechanical engineering. He has been active in the Officers Reserve Corps since 1921. After a number of engineering positions he joined the American Steel and Wire Division, U. S. Steel Co., Cleveland, Ohio, in 1927 as a designer, and has advanced to his present position of division engineer construction.

HARRY W. CLARK, a native of Detroit, Mich., obtained his technical education through various Michigan educational institutions, including the Henry Ford Apprentice School. His metallurgical experience has been entirely with the Ford Motor Co. Steel Operations and he has been associated with the Rouge plant of that company since 1934. In 1942, he assisted in the organization of the quality control department in the open hearth, soaking pits and rolling mill. His promotion to his present capacity as open hearth metallurgist and supervisor of the metallurgical quality control section in the aforementioned operating units came in 1946.

JAMES A. BELL graduated from Bethlehem High School in 1906 and became draftsman apprentice in the engineering department of Bethlehem Steel Co. In the years to follow, he assisted in the design of a number of large rolling mills with that company, and was connected with the heavy machinery, ordnance and construction engineering departments. He also worked in the mills at Bethlehem's Saucon division. In 1938, he was appointed chief draftsman, and seven years later was advanced to assistant chief engineer. He was promoted to his present position of chief engineer of the Bethlehem plant in 1946.

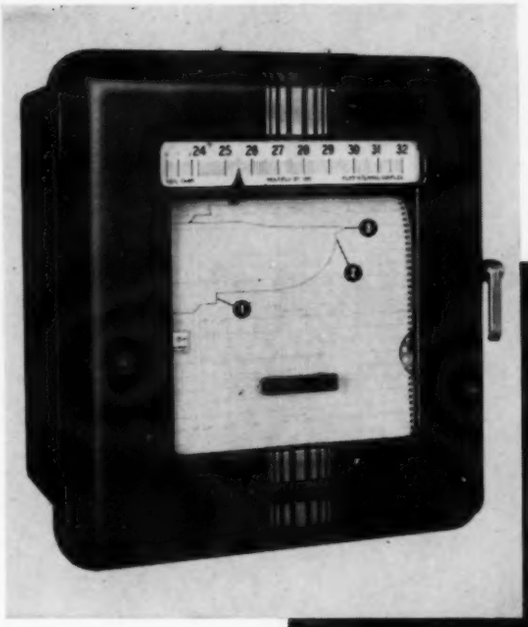
JAMES D. O'ROARK was born in Broadway, Va., and received grade and high school education in Covington, Ohio. He graduated from Ohio State University in 1926 with a degree in electrical engineering. After graduation, he was employed in a student engineer training course and on the test floor from 1926 to 1930 at Westinghouse Electric Corp.'s East Pittsburgh works. He has been employed by Weirton Steel Co., from 1931 to present date as electrical field engineer, electrical foreman of strip steel and sheet mill department, assistant electrical superintendent, electrical superintendent, and assistant to manager of service and maintenance department, which last position he now holds.

**WALTER V. MAGEE**
CLEVELAND DISTRICT SECTION

**HARRY W. CLARK**
DETROIT DISTRICT SECTION

**JAMES A. BELL**
PHILADELPHIA DISTRICT SECTION

**JAMES D. O'ROARK**
PITTSBURGH DISTRICT SECTION



*Significant points on chart of Speedomax Immersion Thermocouple Recorder at left are: (1) standardization of recorder circuit during couple immersion; (2) temperature of steel bath, and (3) increase in thermocouple temperature during withdrawal through slag. Entire measuring sequence is swiftly recorded by Speedomax in less than one minute.*

*In the illustration below, an operator plunges an L&N Immersion Thermocouple, connected to a remotely-located Speedomax Recorder, into the steel bath . . . withdraws it as soon as the Recorder signals that temperature measurement is complete.*

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### *of Bath Temperature Measurements*

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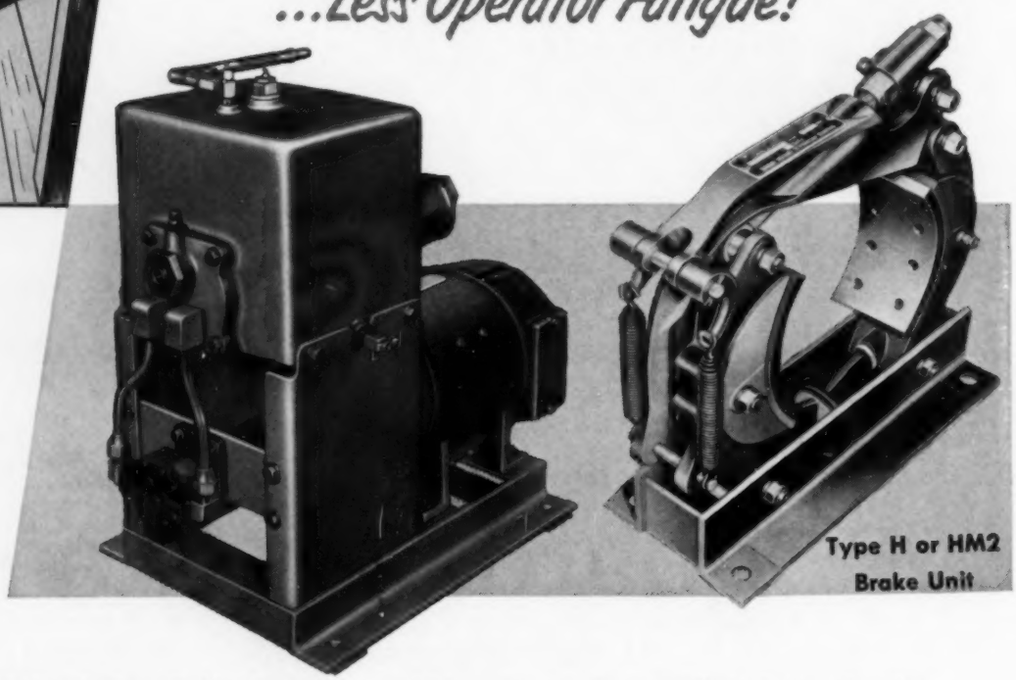

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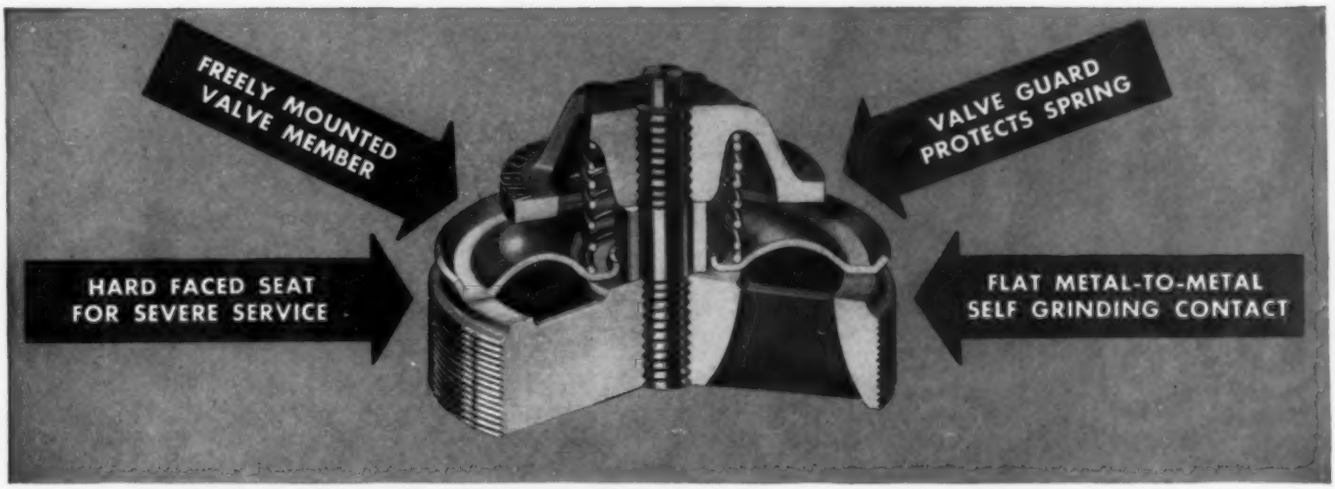
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H. T. Walker, Chief Electrician,
Crescent Insulated Wire and Cable Co.
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H. T. Walker, *Chief Electrician*
Cresent Insulated Wire and Cable Company
Trenton, New Jersey

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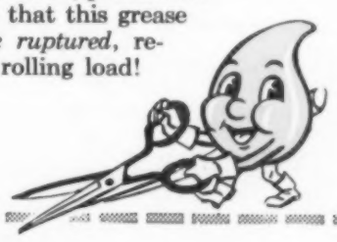

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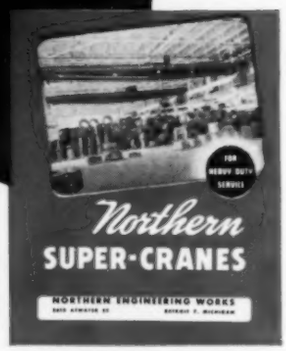


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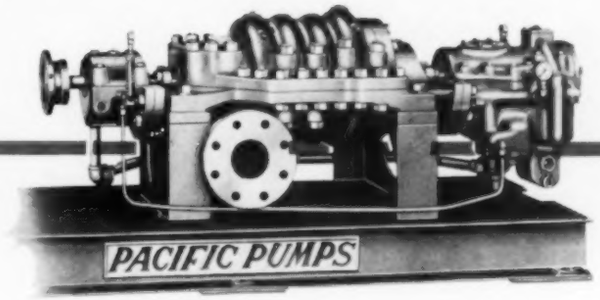


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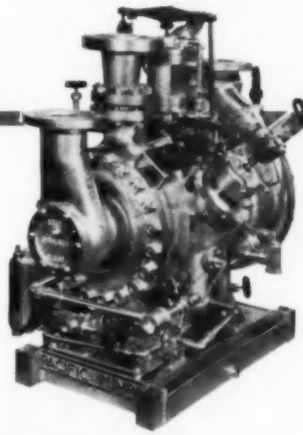

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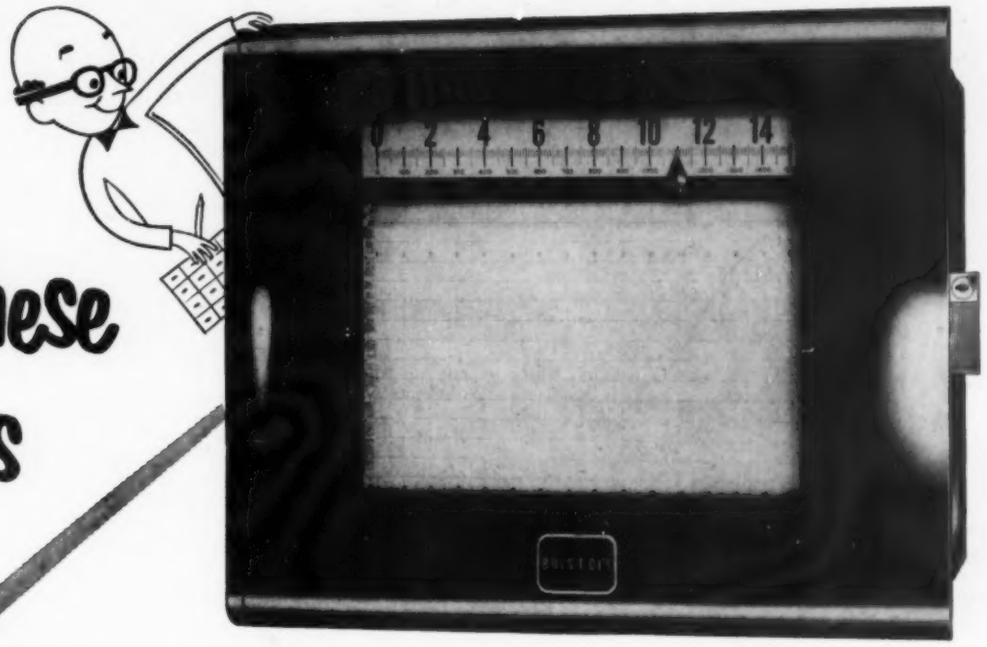

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***—the electronic master-mind for your temperature measuring, recording and controlling problems***

- ✓ Continuous-balancing electronic circuit responds instantly to minute changes
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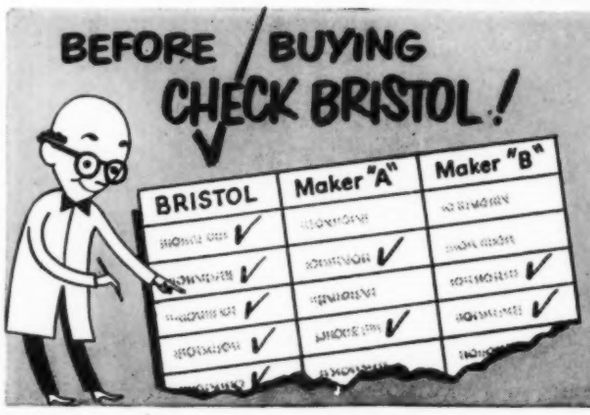


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Typical Koppers-Becker Coke Ovens. This battery of 65 ovens carbonizes approximately 1,400 net tons of coal per day at a coking rate of 1.08 inches per hour.

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New Freyn-Design Blast Furnace. Soaring 225 feet skyward, this furnace has a hearth diameter of 25 feet and a capacity of 1,100 net tons of iron per day.

Hess-Bright Pillow Blocks

# NEW from SKF
# the HESS-BRIGHT "SY" UNIT PILLOW BLOCK

*A new Unit Pillow Block, designed by SKF to meet tomorrow's needs of modern industry.*

*Here are the design features:*

- SKF Red Seal, made of DuPont Fairprene, retains lubricant. Wiping action of the seal against the inner ring is practically frictionless.
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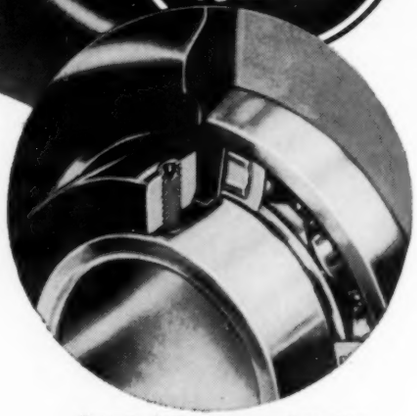

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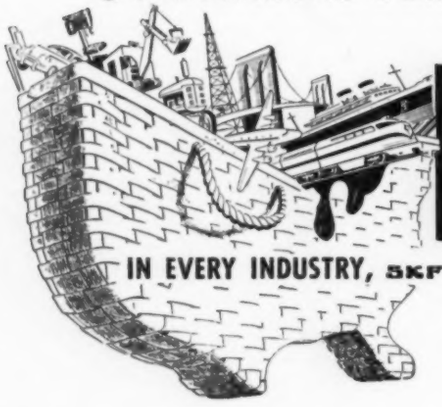
From now on, the name to remember in Unit Pillow Blocks is HESS-BRIGHT "SY"—manufactured in our plants, to the same high quality standards as all SKF products. Ask your SKF Distributor to show you the HESS-BRIGHT "SY"; or write SKF direct for complete information on this *newest* Unit Pillow Block.



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# Date-line Diary...

**October 1**

▲ Kaiser Steel Corp. announced net income for the year ending June 30, 1952 totaled $10,399,306 after taxes and charges compared with $7,510,560 for the year 1951. Net sales totaled $117,925,049 compared with $100,471,475 for 1951.

**October 2**

▲ The Federal Reserve Board reported that consumer credit outstanding reached a record high of $21,300,000,000 at the end of August. In August U. S. consumers went $173,000,000 further in debt.

▲ Defense Mobilizer Fowler told the House-Senate Committee on defense production the government will set a goal to produce additional annual capacity of 200,000 tons of aluminum, which would raise the nation's aluminum capacity to 1,700,000 a year.

▲ In August manufacturers' sales rose to $22,900,000,000, or 2 per cent above July figures. On August 31, inventories of all manufacturers totaled $42,300,000,000 compared with $40,200,000,000 in August 1951.

**October 3**

▲ The Labor and Commerce Departments reported construction outlays in the September quarter were valued at $9,300,000,000, compared with $8,700,000,000 for the same 1951 period.

**October 4**

▲ For the three months ending September 30th, the government spent $17,800,000,000, while $13,900,000,000 was taken in by the Treasury, thus going $3,900,000,000 in the red. Both figures were above the prior year's rate.

▲ The Commerce Department announced that United States employment in September was 62,260,000. Unemployment declined to 1,400,000 in September.

**October 6**

▲ In a quarterly report to the president, Defense Mobilizer Fowler stated that industrial expansion projects aided by fast tax write-off allowances totaled $24,000,000,000. These will be about one-half completed at the end of 1952.

▲ According to the AISI, the operating rate of the steel industry for the week beginning October 6 for companies having 93 per cent capacity of the industry is scheduled at 104.6 per cent of capacity. This is equivalent to 2,173,000 tons of steel ingots and castings compared with 2,160,000 tons one week ago.

**October 7**

▲ A battery of 35 new coke ovens costing an estimated $6,000,000, has been placed in operation by Pittsburgh Coke & Chemical Co. at its Neville Island plant. These will boost the company's coking capacity at least 35 per cent.

**October 8**

▲ The price of zinc dropped ½¢ to 13½¢ a lb in East St. Louis. Lead dropped 1¢ to 15¢ a lb.

▲ The Lake Carriers' Association announced that ten new iron-ore carrying vessels are under construction or on order, which will have a carrying capacity of 184,000 gr tons, and when commissioned will be able to transport an additional 7,000,000 gr tons in a full season.

**October 9**

▲ The tin mines of Hochschild, Patino and Aramayo have been seized by the Bolivian government.

▲ A loan of $100,000,000 from a group of banks has been arranged by Bethlehem Steel Corp. through Guaranty Trust Co. of New York. This is the company's second $100,000,000 loan, the first being used for an expansion program now under way.

▲ Commerce Department reports that in August personal income rose to an annual rate of $267,100,000,000, up $3,000,000,000 from July. This rise is attributed to late July settlement of the steel strike.

▲ In London the price of lead dropped to 10 1⅝₁₆¢ a lb, or 5½¢ a lb less than the London government's official quotation.

▲ The OPS agreed to settle its case against Barium Steel Co. and two affiliates Phoenix Iron and Steel Co. and Central Iron & Steel Co. for $1,011,123. The companies were accused of charging above-ceiling prices for steel products.

▲ For the last three months of 1952, Mystic Iron Works, Everett, Mass. has reduced the base price of foundry pig iron to $59.25 a ton instead of $59.75.

**October 10**

▲ Directors of the Interlake Iron Corp. have voted to purchase the remaining 30 per cent interest in Dalton Ore Co. from Mather Iron Co., and according to Ronald W. Thompson, president, Interlake Iron Corp. will thus acquire complete and outright control of its ore reserves.

▲ The Commerce Department estimated that business inventories at the end of August amounted to $68,600,000,000, up $600,000,000 from July.

▲ Plans have been announced by Kaiser Steel Corp. to increase production of coking coal to 1,600,000 tons annually at its Sunnyside, Utah mines.

▲ According to the ARCI, deliveries of new domestic freight cars in September were 3762 compared with total deliveries of 8533 cars for the same period in 1951, showing the effect of car building materials shortage resulting from the steel strike. Orders for new freight cars totaled 3628 and the backlog of cars on order as of October 1 was 95,377.

▲ Dr. George E. Holbrook, Director of the Chemical Division of NPA, announced that approximately $5,000,000,000 will be invested in the expansion of production facilities by the chemical industry during the period between 1951-1955.

**October 11**

▲ The price of tin rose 2¢ a lb to $1.23⅜ in London, or 2½¢ above the price one week ago.

▲ The Commerce Department reported that in September dividend payments by United States corporations totaled $1,158,000,000, or 1 per cent above the same period in 1951.

▲ As the result of a decree by the French cabinet steel prices in France will come out from under control of the Comptoir Siderugique de France and go under control of government ceilings.

▲ A $40,300,000 pig iron and coke plant will be built by the newly formed Niagara River Steel Corp. near Buffalo, N. Y. The DPA has authorized the firm to depreciate 85 per cent of the cost in the next five years for tax computation.

▲ The Aluminum Association reports that the August output of primary aluminum totaled 170,350,658 lb, a 12.5 per cent gain over July, and an increase of

15.5 per cent over the same period in 1951. Shipments of aluminum sheet and plate totaled 91,094,081 lb.

▲ Based on reports of companies having 93 per cent of capacity for the steel industry, the operating rate for the week beginning October 13th is scheduled at 105.8 per cent of capacity. This is equivalent to 2,197,000 tons of ingots and castings compared with 2,215,000 tons one week ago.

**October 14**

▲ A new iron ore mine has been opened by Inland Steel Co. near Crystal Falls, Mich. on the Menominee range.

**October 15**

▲ The price of lead was reduced 1¢ a lb to 14¢ in New York.

▲ The Commerce Department reported that United States exports in August totaled $1,070,400,000. Imported goods were valued at $817,000,000.

▲ Federal District Court Judge Albert L. Watson of Scranton, Pa. ruled the sale of Williamsport Wire Rope Co. to Bethlehem Steel Corp. null and void holding that a conspiracy existed in connection with the sale.

**October 16**

▲ According to Engineering News-Record total volume of new construction in 1953 is expected to maintain 1952's record level of about $32,000,000,000.

**October 17**

▲ In an effort to boost production of ferro-alloying materials, Defense Mobilizer Fowler launched a new program aimed at cutting civilian consumption.

**October 20**

▲ According to F. W. Dodge Corp. construction awards for the first nine months of 1952 totaled $12,747,791,000 in the thirty-seven states east of the Rockies.

▲ Based on reports from companies having 93 per cent capacity of the steel industry, the operating rate for the week beginning October 20, 1952 is scheduled at 106.6 per cent of capacity. This is equivalent to 2,214,000 tons of steel ingots and castings compared with 2,211,000 tons one week ago.

▲ The Wage Stabilization Board voted eight to four to cut United Mine Workers pay increase from $1.90 a day to $1.50 on the grounds that such an increase would be inflationary. As a result 375,000 miners stayed away from the pits.

**October 23**

▲ The price of zinc continued to be held at 13½¢ a lb in East St. Louis and 14.33¢ a lb in New York, even though it was reported that zinc from foreign shores is available along the eastern seaboard at 12½¢ a lb.

▲ On November 1, Truscon Steel Co. will become a division of Republic Steel Corp.

▲ The price of lead was dropped ½¢ to 13½¢ a lb by a leading domestic smelter.

**October 24**

▲ At the Midland, Pa. plant of Rem-Cru Titanium, Inc., a $1,000,000 expansion program is under way which will double its ingot capacity.

▲ The price of zinc dropped 1¢ to 12½¢ a lb in East St. Louis.

▲ Machine tool shipments totaled $110,000,000 in September, the highest in ten years.

**October 25**

▲ Bethlehem Steel Corp. announced that the first of two new blast furnaces which will have an annual capacity of approximately 600,000 tons will be in operation in February.

▲ A machine for the continuous casting of steel has been ordered by Atlas Steels, Ltd. for its Welland, Ontario mill, which is scheduled to be in production by late 1953.

**October 27**

▲ Bethlehem Steel Corp. has petitioned Judge Albert L. Watson to set aside his ruling on the controversial sale of Williamsport Wire Rope Co. to Bethlehem.

▲ Based on reports from companies having 93 per cent of capacity for the steel industry, the operating rate for the week beginning October 27 is scheduled at 105.9 per cent of capacity. This is equivalent to 2,199,000 tons of ingots and castings compared with the record total of 2,221,000 tons one week ago.

▲ The AISC reports that September shipments of fabricated structural steel were 226,458 tons, bookings for September were 204,754 tons. The backlog of work as of September 30th is 2,342,374 tons.

**October 28**

▲ Canada's Premier Duplessis announced that a 360-mile rail line into Ungava's iron ore territory will be completed next year.

▲ The week old soft coal strike was called off today by John L. Lewis.

▲ For the quarter ending September 30, 1952, Jones & Laughlin Steel Corp. announced net income of $810,000 or $0.08 per share, revenues of $106,373,000.

**October 29**

▲ Inland Steel Co. reported net sales for the third quarter of $97,892,252, 25 per cent under the previous year. Net income was $4,794,694 or 97¢ per share compared with $1.58 for the same quarter the previous year.

▲ Crucible Steel Co. of America reported net income for the quarter ending September 30th of $2,033,461 or $1.43 per share of common stock compared with $2.64 per share for the same quarter in 1951.

**October 30**

▲ Allegheny Ludlum Steel Corp. reported net sales during the third quarter of 1952 of $33,541,000. Net earnings amounted to $997,000 equivalent to 56¢ per share common stock after preferred dividends.

▲ Under an agreement concluded with the United Kingdom, the Aluminum Co. of Canada and the DPA, aluminum supplies of the United States will be increased by 77,000,000 lb in the first half of 1953.

▲ U. S. Steel Corp. reported income for the third quarter of $30,405,472 or 92¢ a share compared with 83¢ the previous year. Sales were $679,000,000,000.

▲ Youngstown Sheet & Tube Co. reported net income for the third quarter of $2,546,846 or 76¢ a share after taxes on total revenues of $93,257,568. This compares with net earnings of $2.15 a share for the third quarter of 1951.

**October 31**

▲ The Commerce Department reports that manufacturers had a backlog of $74,800,000,000 of unfilled orders on September 30. This is $10,200,000,000 above the same time in 1951.

▲ Bethlehem Steel Co. reported net profits for the third quarter of $17,116,975 or $1.62 per share compared with $1.76 per share one year ago. Total billings for the third quarter were $367,541,367.

▲ Youngstown Sheet & Tube Co. announced that it plans to build a new 76-oven by-products coke battery at the Campbell Works in Youngstown, Ohio. Capacity is estimated at 450,000 tons a year. Estimated cost will be close to $10,000,000.

# CALL Curry! FOR STEEL PLANT EQUIPMENT

If delayed delivery of new equipment is hampering your production schedule, consider good used equipment. We are in a position to offer with immediate delivery and large savings in cost, the steel mill equipment which you now need. At present we have available a wide range of mill machinery including large drive motors, hot strip mills, cold reduction mills, bar and rod mills, cranes, auxiliary equipment, and component parts for all types of mill operations.

Below you will find a partial list of available equipment. For a more complete accounting, write, phone or wire today for the "Curry List." Our service will eliminate your present "bottleneck" and increase your production.

**38" CONTINUOUS HOT STRIP MILL,** consisting of 2 Vertical Edgers, 3 2-High Roughing Stands, 4 4-High Finishing Stands, Flying Shear, Hot Runout Table, and electrical equipment.

**12½" & 38" x 36" 4-HIGH REVERSING COLD REDUCTION STECKEL MILL,** complete with 1800 H.P. Main Drive Motor, and all Auxiliary Equipment.

**SCRAP BALLER. (1949 MODEL—NEVER USED)** 24" diameter x 35" face roll, hydraulically retractible Mandrel, complete with Gear Reducer. Arranged for 10 H.P. Motor.

**2½" & 20" x 7½" REVERSING COLD REDUCTION STECKEL MILL,** complete with Recoiling Equipment, Main Drive Motor, Motor Generator Set, Controls, and Spare Parts.

**30" DIAMETER x 77" U. E. & F. CO. AUTOMATIC RECOILER,** complete with Brake and Gear Reducer, arranged for 250 H.P. Motor.

**2000 H.P., G.E. SLIP RING MILL TYPE MOTOR,** 3/60/2300v 237 RPM, complete with Liquid Slip Regulator and all controls necessary for mill type operation, including Filtered Air Cooling System.

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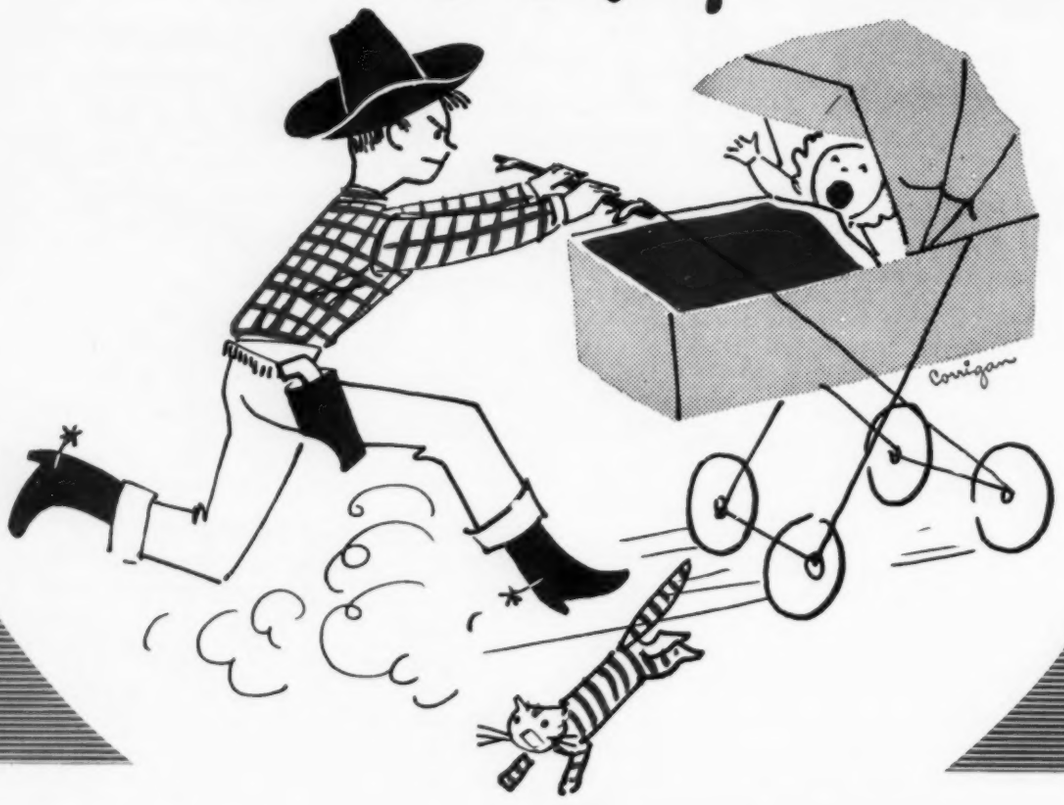
# CHARGING BUGGY?




## no, this is a "Charging Buggy"

This Morgan buggy places billets or slabs in the furnace singly or in multiples so that both ends are equidistant from the furnace walls. The fitting of a telescopic ram to the buggy makes possible the charging of billets and slabs of different lengths. The quick and precise operation of this charging mechanism makes possible an uninterrupted flow of billets or slabs through the heating furnace with resultant uniform temperatures throughout the entire length of the billets or slabs.

Your problem may be different. If it relates to equipment we build, why not talk it over with our engineers?

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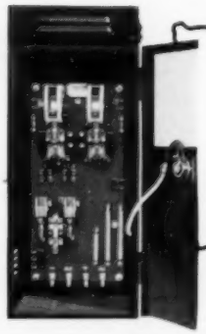
# *Raise the PROFIT level-*
# *Cut the Discharge-time*
## with EC&M MAGNETS and
## EC&M AUTO-DISCHARGE Controllers

LIFT DROP

Small Master Switch—convenient, compact and only 2 positions "Lift-Drop" simplify operator's motions.



Adjustable Controller—only EC&M Bulletin 905 Controllers have a dial permitting operator to adjust for fast, clean releases when voltage varies — material handled changes.

Improved Design Magnet—ALL-WELDED to keep pole shoes tight—keep moisture out—increase the efficiency of the magnetic circuit and prolong life.

55-inch diam. EC&M Type SW ALL-WELDED Magnet speeds handling of large diameter discs stamped from steel-plate.

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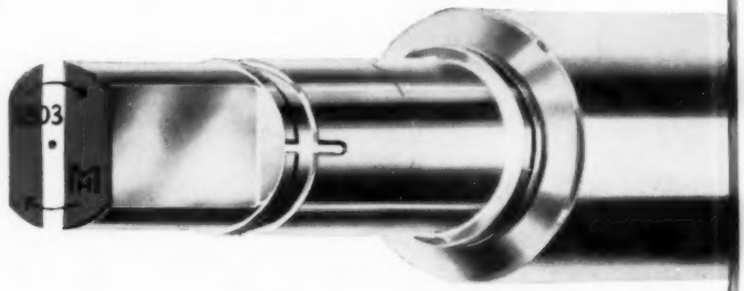
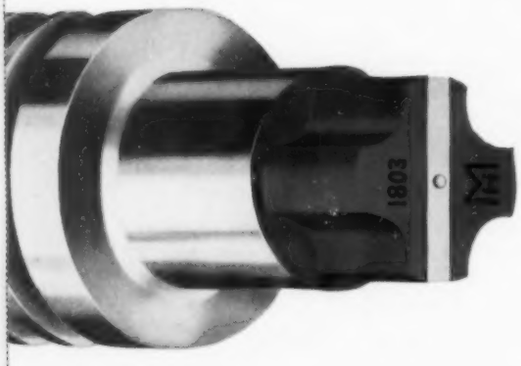
# Up-to-date as a...

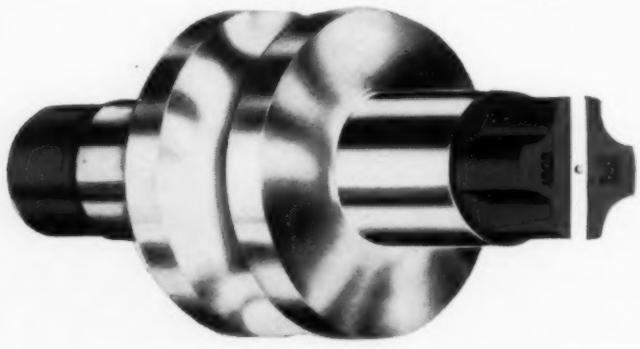
that's how Mack-Hemp's rolls with the *striped red wabblers* are—the latest thing in metallurgical developments and productioneering practice.



The skillful mill operators who make strip or pipe or wire or plate find that Mack-Hemp rolls are equal to the task, and then some.



Because Mack-Hemp keeps pace with modern trends in rolling mill practice, it's important for you to keep your eye on what's new and different at Mack-Hemp.



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**COMPANY**
*Makers of the Rolls with the Striped Red Wabblers*
**PITTSBURGH AND MIDLAND, PA.**

MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: rolls . . . steel and special alloy castings . . . completely integrated strip mills . . . heavy duty engine lathes . . . Mackintosh-Hemphill rotary straighteners . . . improved Johnston patented corrugated cinder pots and slag-handling equipment . . . shape straighteners . . . end-thrust bearings . . . shears . . . levellers

# Industry News...

## MONARCH COMPLETES EXPANSION PROJECT

▲ Monarch Machine Tool Co., Sidney, Ohio, broke ground for a long-planned addition to manufacturing space just 60 days after the first shot was fired in Korea. Completion of this first expansion was immediately followed by another and even larger one which with its completion this month gives Monarch a modern building of 308,000 sq ft area, housing the most modern of production facilities for the manufacture of engine lathes, tool room lathes, a new right angle lathe, and lathe accessories of the latest design.

The new layout features unidirectional flow of materials through much new production equipment; redepartmentalization; abundant materials handling equipment, and adequate heat, light and service facilities. Monarch is operating on a three-shift operation, which has been in effect since early in 1951.

In 1942, the production area of the Monarch plant contained 212,000 sq ft; a far cry from the 9,960 sq ft in which the company started operations in 1909. The two-stage post-Korean expansion has added 43 per cent to the floor space, and during the same period, 25 per cent of the then existent plant and facilities has been modernized. The plant as it now stands is 930 ft long, and, at its widest part, is 386 ft wide.

## REM-CRU EXPANDS TITANIUM FACILITIES

▲ The nation's supply of the new "middleweight champion" metal, titanium is to get an extra boost as a result of the announcement by Rem-Cru Titanium, Inc., that it has started expansion of facilities to more than double the company's ingot capacity.

New melting facilities now being installed in the Rem-Cru plant at Midland, Pa., are scheduled for completion this year, according to W. H. Colvin, Jr., president. Rem-Cru, which was the first concern in the field to offer titanium commercially, has produced titanium and titanium base alloys at a rate exceeding 10 tons a week during 1952. Titanium is currently in wide demand for key defense and industrial uses.

The company currently produces ingots weighing up to 1,200 lb each. New furnaces and changes on existing furnaces will boost ingot sizes to a range of 2,000 to 4,000 lb by the end of 1952, according to Rem-Cru plans.

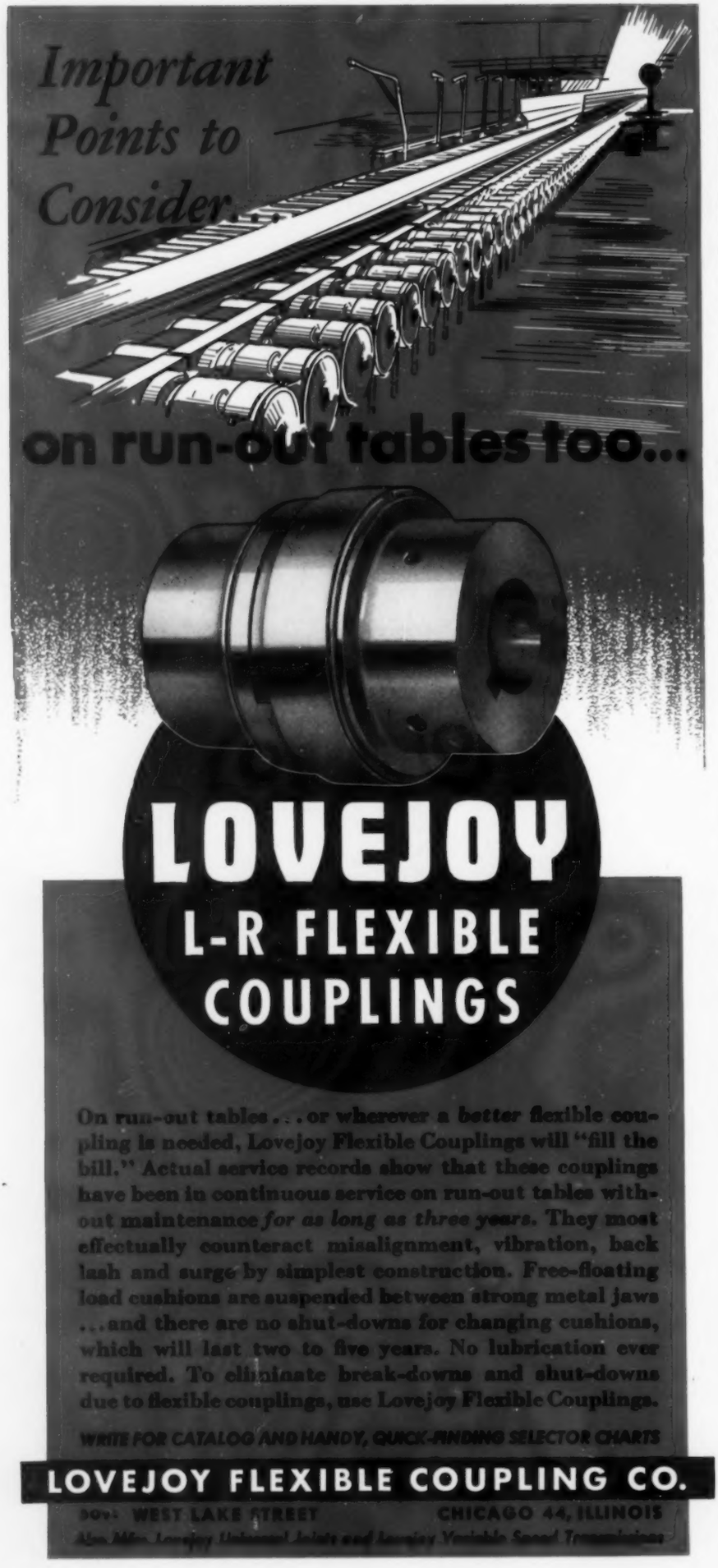
Reporting on details of the expansion, C. I. Bradford, director of Rem-Cru operations, at Midland, stated that a new cold mold electric furnace is being installed that will produce ingots ranging in size from 2,000 to 4,000 lb each. An existing furnace is being enlarged for an ingot size of 2,000 lb.

"These new facilities will enable us to devote two smaller furnaces largely to intensified research and development on melting and alloying titanium," Mr. Bradford said. He pointed out that Rem-Cru development work on melting titanium and titanium alloys represents an investment to date of more than $1,000,000. The special electric furnaces employed are designed and installed by Rem-Cru.

"Our melt shop will occupy twice its present space," Mr. Bradford continued. "Metallurgical laboratory space is being enlarged. A machine shop is being added with equipment selected for work in titanium and titanium plant maintenance. Double the amount of space is being given over to facilities for technical work. sales, and office services. A technical library is being built up in enlarged quarters."

Describing the scope of defense and industrial interests in titanium and titanium base alloys Mr. Bradford said an important application for titanium is being made in aircraft and engine construction. The first commercial aircraft parts designed for titanium are to be used by Douglas Aircraft Co. which is specifying titanium for engine nacelles and firewalls in the new DC7. Titanium materials are high on the priority list for a number of other defense applications. Titanium and titanium base alloys are being used in the fabrication of marine equipment, apparatus for

**Modern facilities, featuring new production and materials handling equipment, are housed in this recently constructed addition to Monarch's Sidney plant.**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L-R FLEXIBLE COUPLINGS
On run-out tables . . . or wherever a better flexible coupling is needed, Lovejoy Flexible Couplings will "fill the bill." Actual service records show that these couplings have been in continuous service on run-out tables without maintenance for as long as three years. They most effectually counteract misalignment, vibration, back lash and surge by simplest construction. Free-floating load cushions are suspended between strong metal jaws ...and there are no shut-downs for changing cushions, which will last two to five years. No lubrication ever required. To eliminate break-downs and shut-downs due to flexible couplings, use Lovejoy Flexible Couplings.
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WEST LAKE STREET CHICAGO 44, ILLINOIS

chemical and other processing industries.

Titanium and titanium base alloys constitute the newest major family of industrial metals. The metal is 44 per cent lighter than steel. In strength, it exceeds aluminum and rivals fine steels. Titanium possesses remarkable resistance to corrosion and its melting point is higher than any other structural metal.

Mr. Bradford reported that there is increasing interest in titanium throughout industry and that Rem-Cru is cooperating in the development of methods for working and using the metals.

Rem-Cru was founded in 1950 and established its production, research and sales headquarters at Midland in 1951. It is jointly owned by Remington Arms Co., Inc., which initiated a titanium development program at Bridgeport, Conn., in 1947, and Crucible Steel Co. of America, which converts the metal into forgings, bars, sheets, strip, wire and other forms at four of its special-purpose steel mills in Midland, Pa., Pittsburgh, Pa., Harrison, N. J., and Syracuse, N. Y.

Development of the Midland plant of Rem-Cru reflects the rate at which Rem-Cru has grown since it was established two years ago. At that time, the size of ingots was about 150 lb each. Ingot sizes were steadily increased up to 1,200 lb. Recently, Rem-Cru finished work on a coil of titanium strip made from a single ingot, measuring 37 in. in width and 460 ft in length. The metal was reduced to a thickness of 15-thousandths of an inch. This is the first titanium "wide" strip and by far the largest commercial coil ever produced.

## CLAIRTON WORKS TO GET BLAW-KNOX SHEAR UNITS

▲ Blaw-Knox Co. has received an order from U. S. Steel Co. for two hot shears to be installed at the Clairton, Pa., works.

One of the units will be used on the 40-in. mill and will be able to shear slabs up to 9 in. thick by 42 in. wide. The other will serve the 28-in. mill and will shear 4, 5 and 6-in. square billets. Both of the lines will be motor operated and will have shears of the up-and-down-cut type. These shears will be made by the Lewis Foundry & Machine Division of Blaw-Knox.

# HERE'S HOW YOU SAVE TIME, CUT COSTS WITH NATIONAL STANDARDIZED BRUSHES

TRADE-MARK

## MR. ELECTRICAL SUPERINTENDENT

. . . "National" STANDARDIZED brushes greatly simplify the application of brushes to your motors and generators. You *start* right, *stay* right with brushes designed specifically for uninterrupted machine operation.

## MR. MAINTENANCE MAN

. . . "National" STANDARDIZED brushes provide the ideal commutation and low friction that spell reduced maintenance cost and sustained, economical operation. Carefully controlled brush grades and tamped-type, vibration-resistant shunt connections team up to help *you*.

## MR. PURCHASING AGENT

. . . "National" STANDARDIZED brushes greatly simplify ordering. They are shipped from stock—FAST—and at the same low cost for 100 or 100,000 brushes. You can carry smaller inventory . . . stock fewer *different* items — and save money in the bargain!

***Write for Bulletin CP-2426***
***"National" Standardized Brushes***

**DOLLARS and SENSE . . .**

point to "Eveready" No. 1050 Industrial Flashlight Batteries . . . delivering twice as much usable light as any battery we've ever made before. Their unique construction prevents swelling or jamming in the case . . . no metal can to leak or corrode.

*The terms "National" and "Eveready" are registered trade-marks of Union Carbide and Carbon Corporation*

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**A Division of Union Carbide and Carbon Corporation**
**30 East 42nd Street, New York 17, N. Y.**

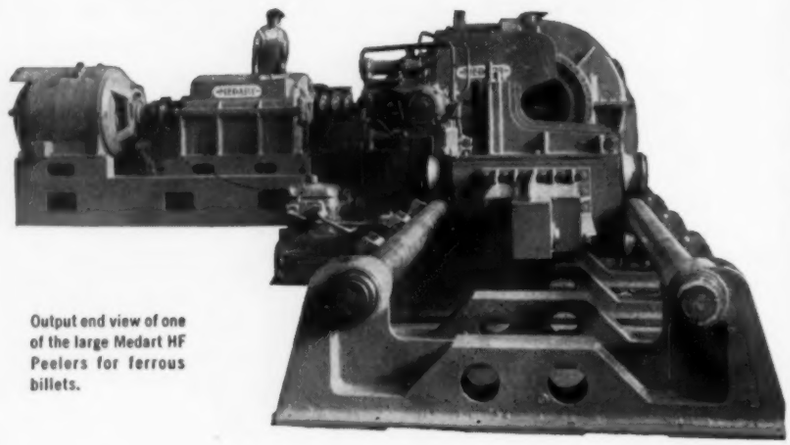
*District Sales Offices:*
Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

*In Canada:*
National Carbon Limited
Montreal, Toronto, Winnipeg

# Billets Peeled at 20', 30', even 40' Per Minute!

# MEDART

## MODEL HF
## BILLET PEELERS



Output end view of one of the large Medart HF Peelers for ferrous billets.

The output of Medart Billet Peelers is limited only by the capacity of the best available cutting tools! That means the absolute maximum in production at the lowest possible cost!

Built to handle both ferrous billets from 1" to 14" diameter — as well as brass, copper, aluminum and other non-ferrous metals — the throughput speeds of these Medart Peelers range from 1' to 40' per minute, depending upon workpiece size and material. They can be equipped with either one or two cutterheads — arranged for high surface finish or heaviest hogging cuts — and furnished with hydraulic or pneumatic controls, with push-pull feed devices, and for completely automatic operation.

No other scalping or turning machines made can match the production speed or economy of Medart's complete line of Billet Peelers.

*Write NOW For Catalog!*

**THE MEDART COMPANY** 3535 DE KALB STREET ST. LOUIS 18, MISSOURI


## McKEE & CO. OPEN CANADIAN OFFICES

▲ Arthur G. McKee & Co., engineers and contractors, Cleveland, Ohio, announced the opening of offices of their Canadian subsidiary, Arthur G. McKee & Co., of Canada, Ltd., at 350 Bay St., Toronto, Ont., and the appointment of Ralph A. Westervelt as vice president to direct the operations of this office. Mr. Westervelt is a native Canadian with 23 years of specialized experience in the field of engineering.

The new Canadian engineering company, which was organized on July 2, 1952, is a subsidiary of Arthur G. McKee & Co., of Cleveland, Ohio. Like the parent company, the Canadian subsidiary will specialize in the design, engineering and construction of petroleum processing facilities, blast furnaces, open hearth shops, rolling mills, ore preparation and treating plants and related facilities. Directors of the new company are H. E. Widdell, H. R. Moorhouse, Myran J. Livingston and Merrill Cox.

In discussing the Canadian company's plans, Mr. Widdell, who is also president of the Canadian subsidiary, stated that all services and facilities of the American organization will be available in Canada through the subsidiary.

The Canadian subsidiary now has in process in Canada two blast furnaces, an open-hearth shop and a sintering plant.

## JOHNS-MANVILLE PLANS COLOMBIAN EXPLORATION

▲ Participation by Johns-Manville Corp. in a company formed to explore asbestos deposits in the Department of Antioquia, Colombia, was announced recently by A. R. Fisher, president.

Participants in the new company, to be known as Asbestos Colombianos, S. A., will include, in addition to Johns-Manville, Eternit Colombiana, S. A.; Sociedad Colombiana de Asbestos Ltda.; and the Institute de Fomento Industrial, a Colombian government organization devoted to promoting the industrial development of the country.

Johns-Manville will furnish the technical personnel for exploring the

# TREADWELL

## STEEL PLATE CONSTRUCTION

DISTILLATION CYLINDERS
9'-0" DIAMETER • 126'-0" LONG • 131,000 LBS. EACH.
EACH CYLINDER SHIPPED IN ONE PIECE

**HOMOGENEOUS LEAD LINED EQUIPMENT**
**OPEN HEARTH AND HOT METAL LADLES**
**STEEL PLANT TRANSFER CARS**
**HYDRAULIC GATES**
**PRESSURE VESSELS**
**PENSTOCKS**
**PIPING**
**OF**

## WELDED OR RIVETED CONSTRUCTION

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**MIDLAND, PENNA.**

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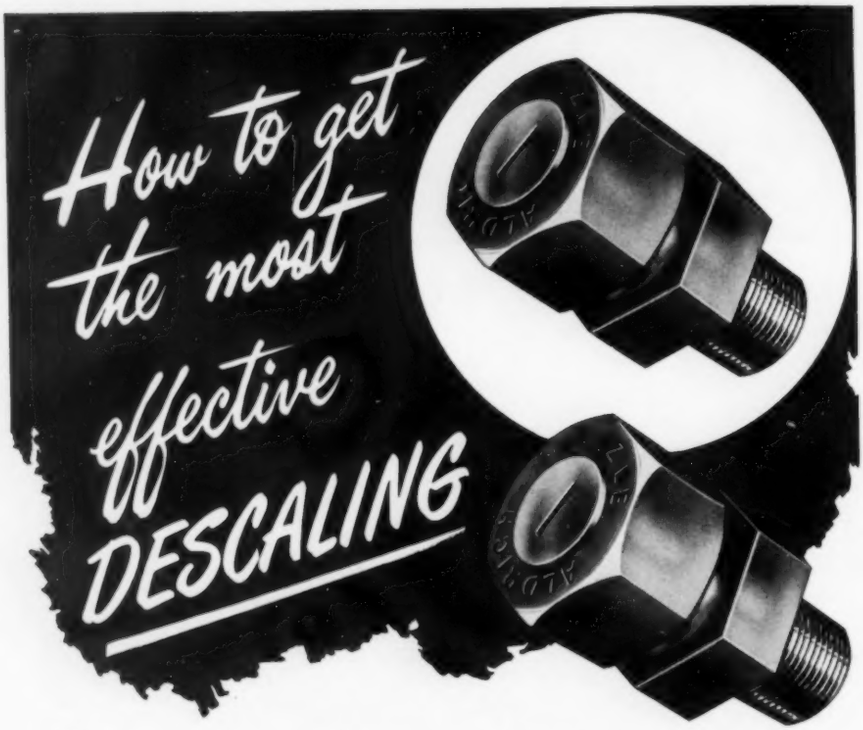
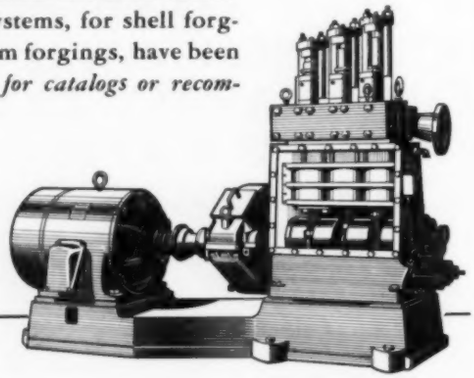
ATlantic 1-2883




Descaling is most effectively accomplished by means of the impinging force of a thin solid jet of water produced by high pressure. Scale is loosened in a fraction of a second by this force and by contraction due to cooling; it is then washed off by the deflected stream of water. The sharp, knife-edge of water and the solid striking force developed by *Aldrich Patented Spray Nozzles* give far more effective descaling than jets of equal force but with a larger impinging area, produced by more water at lower pressure—as proven in hot strip as well as billet descaling.

Several types of Aldrich Spray Nozzles are available from stock. *Write for Data Sheet 61-2.*

*Aldrich Direct Flow Pumps* used for descaling systems are fitted with automatic by-pass valves which operate with all types of accumulators. Both descaling cabinets and hydraulic systems, for shell forgings and other small to medium forgings, have been designed by Aldrich. *Write for catalogs or recommendations.*



THE ALDRICH PUMP COMPANY

21 PINE STREET, ALLENTOWN, PENNSYLVANIA

*. . . Originators of the Direct Flow Pump*

Representatives: Birmingham • Bolivar, N. Y. • Boston • Buffalo • Chicago • Cincinnati Cleveland • Denver • Detroit • Duluth • Houston • Jacksonville • Los Angeles • New York Omaha • Philadelphia • Pittsburgh • Portland, Ore. • Richmond, Va. • St. Louis • San Francisco Seattle • Spokane, Wash. • Syracuse • Tulsa • Export Dept.: 751 Drexel Building, Phila. 6, Pa.


Antioquia deposits to determine their economic value, Mr. Fisher said, and, if the exploration results are favorable, will design a mill and other facilities necessary to the production of asbestos fibre. Johns-Manville will also provide research facilities at its Research Center at Manville, N. J., for the purpose of testing, grading and assaying asbestos fibre produced by Asbestos Colombiana, S. A.

Mr. Fisher said that the formation of the new enterprise to explore Colombian asbestos resources was made possible by the cooperation and aid of President Laureano Gomez of Colombia; and Acting President Dr. Roberto Urdaneta Arbelaez; Minister of Mines and Petroleum Rodrigo Moguera Laborde; and Manager of the Instituto de Fomento Industrial Juan de Dios Ceballos, as well as progressive Colombian business and financial interests.

## McKAY CO. COMPLETES GIANT SLING CHAIN

▲Things are back to routine production at the McKees Rocks, Pa., plant of McKay Co. The "chain" is finished! The "chain" being a mammoth fire-welded double sling-chain with a reach of 35 ft to be used by the Mesta Machine Co., Pittsburgh, Pa., for lifting heavy rolling mill parts.

Designed by McKay company engineers, the total weight of the finished double branch sling-chain is 7,013 lb. There's enough steel in the assembly to make 3,982,384 ordinary 4-penny nails of the common household variety.

The chain links were individually fire welded from a 3 in. diameter wrought iron bar in much the same manner employed by chain makers since medieval days. But, of course, with the advantages of modern equipment. Early blacksmiths, using hand-pumped bellows, heated and shaped bars over anvils to form links, and fire-welded the ends together by hammering with heavy sledges. While the links for this huge sling-chain were fire welded to insure satisfactory fusion of the metal, modern mechanized equipment did the heavy work.

Each finished link has an inside diameter of 4 in. by 7 in. and weighs 51 lb. The forward steel hooks weigh 500 lb each; the pear-shaped link, which was pounded from 5 in. diameter steel bar, measures 36 in. by 17

**This 35-ft fire-welded sling chain will be used for lifting heavy rolling mill parts by the Mesta Machine Co.**

in. by 14 in. inside diameter and weighs 645 lb.

The McKay chain plant in McKees Rocks is one of the few fire welding plants in the country capable of handling jobs of this size. Too, the skill and knowledge of fire-welding is handed down from father to son, and those craftsmen left to practice the art in this country are much in demand.

## KAISER TO SUPPLY PIPE FOR TEXAS OIL LINE

▲Kaiser Steel Corp., Oakland, Calif., has announced it has negotiated a firm contract with Ebasco Services, Inc., as agent for the West Coast Pipeline Co., to supply approximately 88,000 tons of 24-in. and 26-in. steel pipe for a crude oil line from Wink, Tex., to the Los Angeles area.

Kaiser Steel will begin delivery of the order, which represents 45 per cent of the total tonnage of pipe required for the line, in the first quarter of 1953. The entire order is to be filled by the end of the third quarter.

B. E. Hull, chairman of the board of West Coast Pipeline Co., and L. M. Glasco, president, in announcing recently their intention to construct the 1,000-mile line, revealed that the original capacity of the line will be 200,000 barrels of crude oil a day, to be increased to 300,000 barrels later by the erection of additional pumping stations along the line.

They said the line should contribute immeasurably to the long range development of the west because it will supplement the existing crude oil supplies of California refiners and utilize excess refining capacity in the Los Angeles area.

The rate for transporting crude oil through the line will be considerably less than the rate by railroad tank car. Further, according to the West Coast Pipeline officials, the greater amount of salable products that can be refined from the higher gravity Texas crude will more than offset the cost of transporting the oil to California.

Since the entire route is within the confines of the United States, the new pipeline is expected to be an important aid in national defense, particularly in respect to the Pacific Basin.

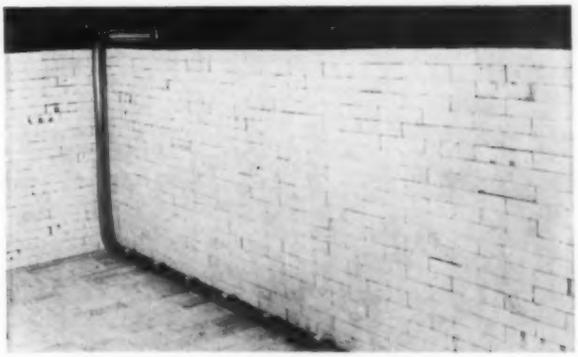
## AMERICAN GROUP BUILDS NEW CENTER IN GERMANY

▲The cornerstone for a new research center at Frankfurt/Main, in Germany, to serve the industry of that country, was placed October 31. The new Battelle Memorial Institute for Germany is being established by Battelle Memorial Institute, American research foundation at Columbus, Ohio.

*(Please turn to Page 170)*

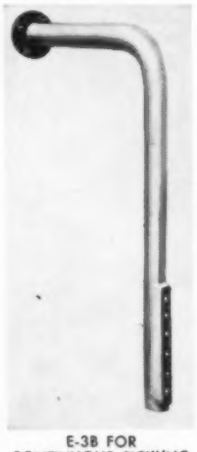

# HERE'S HOW YOU CAN *INCREASE* TONNAGE PICKLED

**Use Heil Steam Jet Agitators For *Uniform* And *Complete* Agitation**



E-3 TYPE JET FOR CONTINUOUS PICKLING

•**INCREASE TONNAGE PICKLED.** Field reports show increase in tonnage pickled from 20% to 40% due to this uniform and complete agitation.



E-3B FOR CONTINUOUS PICKLING

•**LONG SERVICE LIFE.** Patented Impervious Graphite nozzle construction gives longer service life under most severe operating conditions.

•**HIGH EFFICIENCY.** Standard designs are available to give uniform agitation in all type of operations. Continuous — Batch — Tube — Rod.

•**SAVES ACID.** Violent agitation makes possible the use of lower concentration of acid — thus reducing acid consumption.

*Write today for illustrated Bulletin 43-A.*

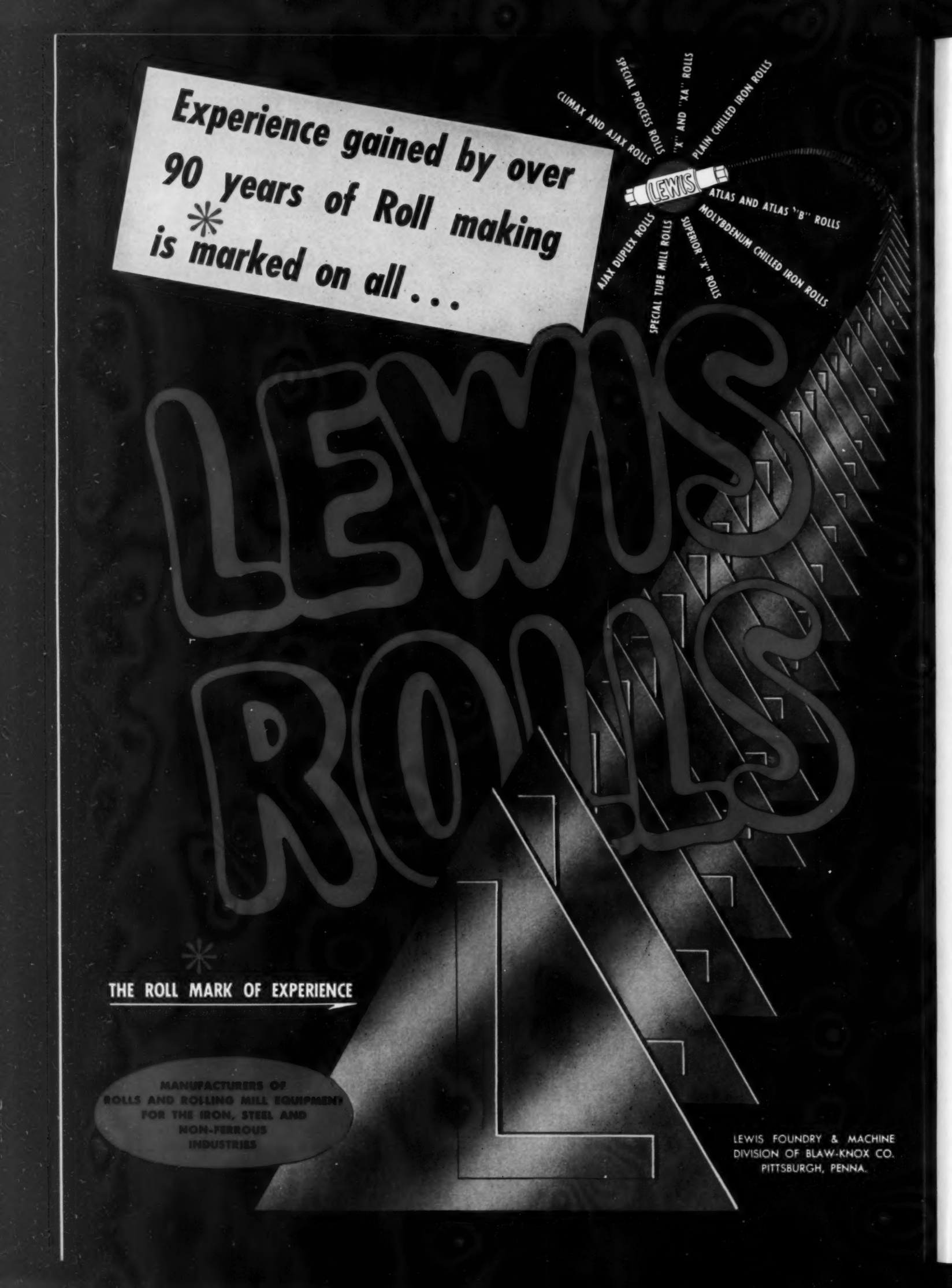
*Used in all Leading Mills throughout United States and Canada.*

*Representatives Located in all Principal Cities*

**HEIL PROCESS EQUIPMENT CORP.**

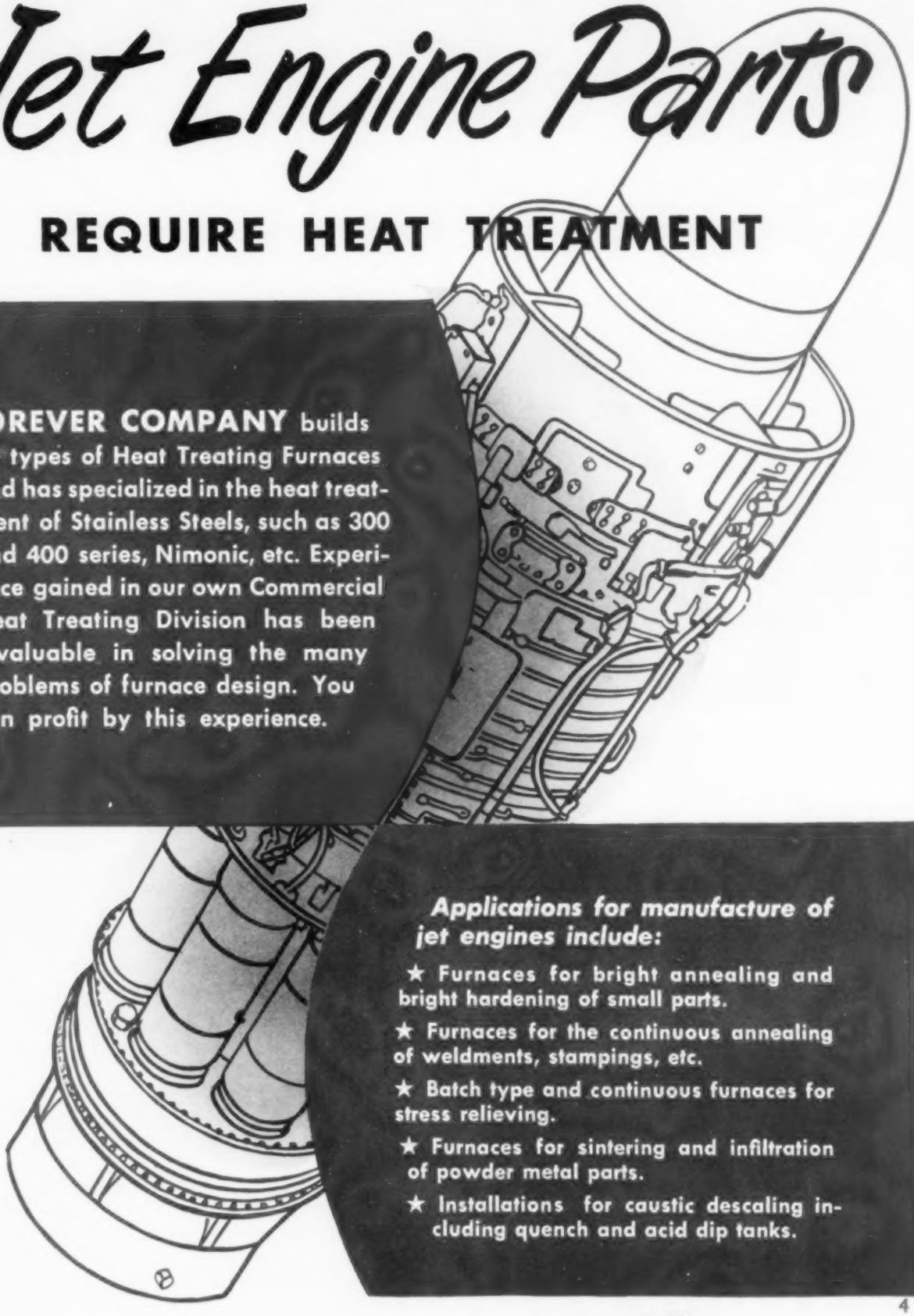
**12901 ELMWOOD AVE. CLEVELAND 11, OHIO**

**OTHER HEIL PRODUCTS INCLUDE: Lined Pickling Tanks • Acid-Proof Maintenance Material • Lead Fabrication • Monel Crates and Hooks • Lined Steel Pipe • Plastic Ducts**


Experience gained by over 90 years of Roll making is marked on all...
CLIMAX AND AJAX ROLLS
SPECIAL PROCESS ROLLS
"X" AND "XA" ROLLS
PLAIN CHILLED IRON ROLLS
LEWIS
ATLAS AND ATLAS "B" ROLLS
MOLYBDENUM CHILLED IRON ROLLS
SUPERIOR "X" ROLLS
SPECIAL TUBE MILL ROLLS
AJAX DUPLEX ROLLS
LEWIS ROLLS
THE ROLL MARK OF EXPERIENCE
MANUFACTURERS OF ROLLS AND ROLLING MILL EQUIPMENT FOR THE IRON, STEEL AND NON-FERROUS INDUSTRIES
LEWIS FOUNDRY & MACHINE DIVISION OF BLAW-KNOX CO. PITTSBURGH, PENNA.

# Jet Engine Parts

## REQUIRE HEAT TREATMENT



**DREVER COMPANY** builds all types of Heat Treating Furnaces and has specialized in the heat treatment of Stainless Steels, such as 300 and 400 series, Nimonic, etc. Experience gained in our own Commercial Heat Treating Division has been invaluable in solving the many problems of furnace design. You can profit by this experience.

***Applications for manufacture of jet engines include:***

★ Furnaces for bright annealing and bright hardening of small parts.

★ Furnaces for the continuous annealing of weldments, stampings, etc.

★ Batch type and continuous furnaces for stress relieving.

★ Furnaces for sintering and infiltration of powder metal parts.

★ Installations for caustic descaling including quench and acid dip tanks.

4

*Let our engineers with their practical know-how, built up thru years of experience, discuss your problems with you.*

**DREVER CO.**

730 E. VENANGO STREET

PHILADELPHIA 34, PA.

(*Continued from Page 167*)

Simultaneously Battelle announced that Battelle is establishing another research center at Geneva, Switzerland, and has set up a program of fellowships for selected students in the universities of both Switzerland and Germany. In addition, research centers and fellowship programs for other countries of Western Europe are contemplated for the future.

The Frankfurt research center will engage in chemical, metallurgical, and engineering research. It is already under construction on a site presented for the purpose by the City of Frankfurt. The laboratory will cost an estimated one million dollars, and another half-million will be required to equip it.

Battelle-Frankfurt has been licensed by the Bonn government to operate as an "eingetragener Verein," that is, as a nonprofit organization. The decision to offer land for the new research center was made by Lord Mayor Kolb, Mayor Leiske, and the City Council of Frankfurt. With their offer they extended congratulations on the establishment of Battelle-Frankfurt and their assurances that Battelle's work will flourish in Germany and in Western Europe.

Plans call for the Frankfurt laboratories to be completed for occupancy by late spring of 1953. The physical plant there will consist of two major buildings, one four-story building 279 by 85 ft, and one three-story building 279 by 92 ft. These will be connected by a three-story bridge. Another one-story building, independent of the other units, will be constructed to house heating and pumping equipment.

Battelle in Europe established offices in Geneva, Switzerland, some months ago, and now has an engineering economics group working on industrial surveys. It is now preparing laboratory facilities on a 16-acre plot there. The Swiss laboratory, which formerly housed medical research, is being remodeled and is scheduled for completion and occupancy early next year. Initially a staff of fifteen will be housed there.

Funds have been allotted by Battelle for approximately 20 fellowships in Swiss and German universities. In Switzerland these funds will be administered by the Swiss Federal Institute of Technology; in Germany by the Stiflerverband Fur Die Deutsche Wissenschaft, e.v. (Foundation for German Science).

Battelle in Europe now has a staff numbering 35, including citizens of Germany, Belgium, Switzerland, France, Holland, and England. A skeleton force of American staff members is now working in Europe on "an extended loan basis." In keeping with the original purpose for Battelle's European program, staffs of Battelle's European units, according to Dr. Williams, will be made up predominantly of Europeans.

Battelle-Frankfurt has temporary offices at DECHEMA-Haus, Rheingau-Allee 25, Frankfurt, Germany. DECHEMA-Haus serves as headquarters for the German chemical industry.

## NEW ENGINEERING CO. OPENS IN PITTSBURGH

▲ Equipment & Controls Engineers, Inc., is the name of a new engineer-

WILL YOUR LADLE LININGS HANDLE UP TO
100,000 TONS
BEFORE REPLACEMENT?
There is no guesswork when you specify BUCKEYE!
Buckeye Silica Firestone ladle linings have averaged about 55,000 tons of iron in 80-ton ladles and approximately 75,000 tons of iron in 125-ton ladles. In many instances, linings have carried over 100,000 tons of metal before being replaced!
The same assurance of super-efficiency can be yours when you decide to reline your ladles with Buckeye Silica Firestone. The cost of sculling out the old lining and completely replacing it with Buckeye is less than one cent per ton of metal carried, labor and material included! Decide today to take advantage of Buckeye's superior quality and attractive cost. Write us and a refractory engineer will call at once!
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BUCKEYE
"FOR THAT EXTRA SERVICE"
SILICA FIRESTONE

# TNEMEC PRIMERS KILL RUST!

THE first step in preserving steel with paint is applying the prime coat. Its primary job is to prevent and kill rust action. TNEMEC Primers do just that, by creating a neutral condition on steel surfaces, changing active rust and corrosive agents into an inactive neutral compound.

The second step is applying the finish coat that will provide protection against the specific exposure hazards involved.

### WHAT IS YOUR EXPOSURE HAZARD?

Is it the humid, salt-air atmosphere of coastal areas? Is it the acid-laden atmosphere found in and around industrial plants, refineries, steel mills, the processing industries, etc? Is it submersion in sewage treating vats, in salt brine, or in fresh water tanks?

No matter what your problem is, there is a TNEMEC Finish Coat to solve it. And remember . . . you will always save many maintenance dollars by doing the job *right*.

## Ask Any TNEMEC User
(TEE-NEE-MIK)

MAIL THIS COUPON FOR YOUR COPY OF TNEMEC CATALOG 50

SEE OUR CATALOG IN SWEET'S

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Send my copy of your Catalog 50 to:

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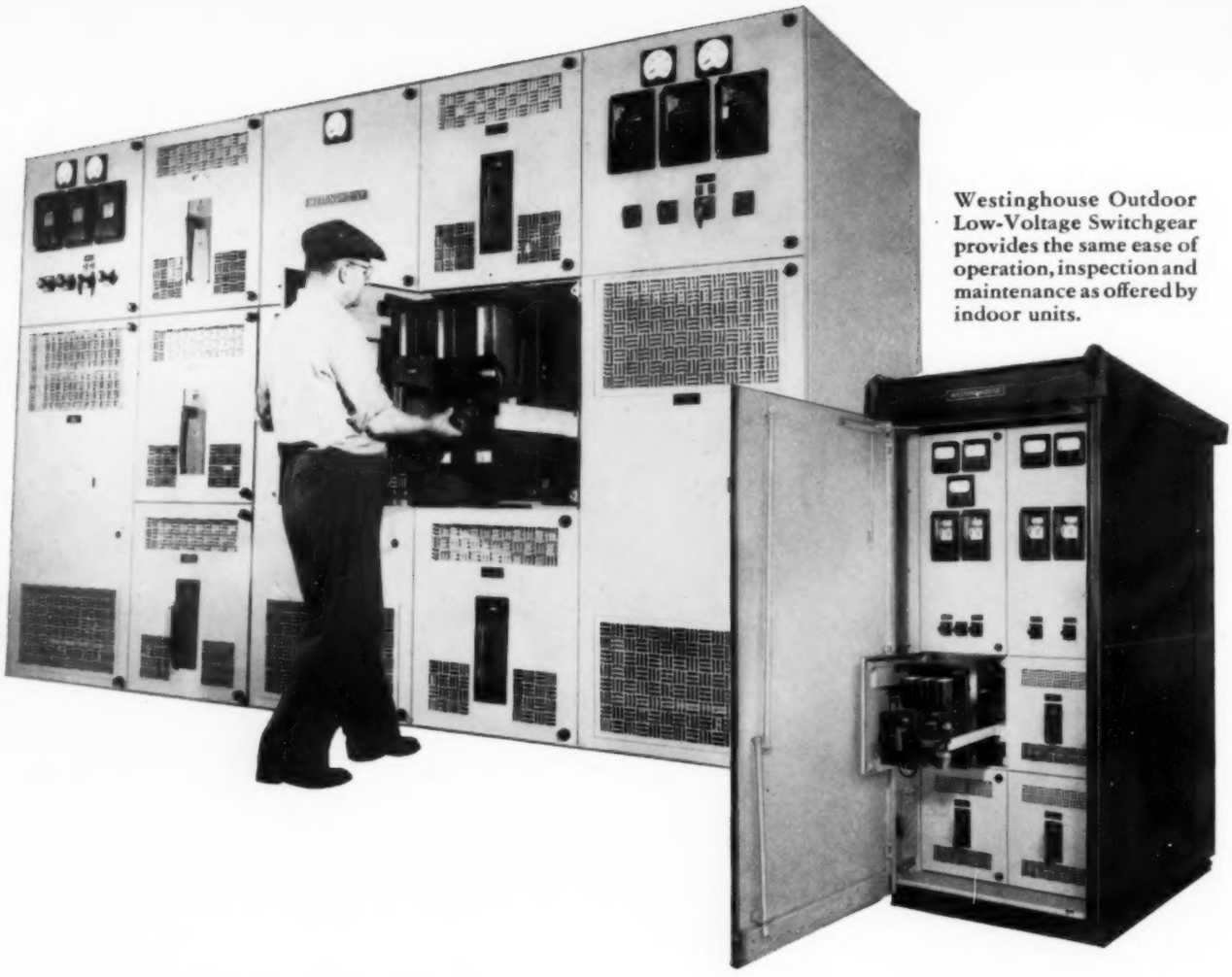


Westinghouse Outdoor Low-Voltage Switchgear provides the same ease of operation, inspection and maintenance as offered by indoor units.

# Now . . . flexible protection in less space

## WITH WESTINGHOUSE LOW-VOLTAGE SWITCHGEAR

When you specify Westinghouse Low-Voltage Switchgear you get the most flexible low-voltage circuit protection available today. And you get it in compact, unitized enclosures that save valuable plant space . . . save you considerable planning expense . . . can be installed in a matter of hours.

An unusual degree of flexibility results from the modern selective tripping feature of the DB De-ion® Breaker. In a single, compact device, you get the perfect co-ordination of time-delay characteristics, which confines outages to the faulted section alone, to assure maximum continuity of service.

The Westinghouse Low-Voltage Switchgear design provides easy access to all components . . . simple drawout breaker operation . . . a complete metal enclosure for safety. It is available for circuits up to 600 volts, 15,000 to 100,000 amperes interrupting duty, for indoor or outdoor service.

For complete information on Westinghouse Low-Voltage Switchgear, write for Booklet B-5282. Address: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-60794

YOU CAN BE SURE... IF IT'S Westinghouse

LOW-VOLTAGE SWITCHGEAR

DESIGN TESTED AND VERIFIED in the Westinghouse HIGH POWER LABORATORY

ing organization specializing in the designing and building of complete coordinated process controls. Walter F. Gieryk has been named president, and Mifflin S. Jacobs, vice president.

The new firm, located at 814 Noblestown Road, Pittsburgh 5, Pa., is equipped to completely handle the design, supervision of installation and procurement of all engineered control equipment.

## SALES REPRESENTATIVES APPOINTED BY RELIANCE

▲Appointment of Smithco Engineering as sales representatives for Reliance Electric & Engineering Co. throughout Oklahoma has been jointly announced. Smithco Engineering maintains its offices at 3348 South Erie St., Tulsa, Okla.

O. L. Smith, owner, and James H. Lee, engineer, are both application specialists with wide experience in electric motor drive problems.

## COMMITTEE'S REVISION RECEIVES ASA APPROVAL

▲ A 1952 revision of the American Standard, Preferred Thicknesses for Uncoated Thin Flat Metals (Under 0.250 in.), B32.1-1952, has just been approved by the American Standards Association. It has been developed by ASA Committee B32, on Wire Diameters and Metal Thicknesses, jointly sponsored by the American Society of Mechanical Engineers and the Society of Automotive Engineers. Chairman of the committee is I. V. Williams, Bell Telephone Laboratories.

## HEWITT-ROBBINS OPENS BUFFALO PLANT ADDITION

▲ Top management of Hewitt-Robbins, Inc., joined with employees and public officials recently to dedicate a $1,000,000 addition to the company's conveyor belt plant in Buffalo, N. Y. The new facilities will increase Hewitt-Robbins' conveyor belt production capacity by 41 per cent, and will make the plant one of the largest and most modern in the world. New equipment includes a press costing $220,000 which will make belts up to 72 in. wide compared with the previous limit of 60 in.


**Maybe your business isn't LUMBER . . .**

**. . . or PINEAPPLES**

**BUT . . .** just imagine the savings you could make, the problems you could solve by handling your materials with ROSS Straddle Carriers, the most flexible and most adaptable mass material handling method known!

ROSS engineers will be glad to work with your materials handling men in exploring the possibilities of ROSS Straddle Carriers for your operations . . . there's no obligation.

Send for details on ROSS Straddle Carriers . . . 10,000 lb., 20,000 lb., 35,000 and 45,000 lb. capacities.

Rely On ROSS

**THE ROSS CARRIER COMPANY**

*Direct Factory Branches and Distributors throughout the world.*

400 Miller St., Benton Harbor, Michigan, USA

F&Y CONTINUOUS STRIP PICKLING LINE

NEW • EFFICIENT • ECONOMICAL

**Complete line equipment with latest improved operating features. Maximum volume production with minimum floor space requirements.**

**If you are interested in a new installation or improving your present equipment why not investigate the Youngstown Line!**

*these features*

- ☐ Coil Box with Strip Opener.
- ☐ Triple Processor with Roller Leveller.
- ☐ Flash Welding and Mechanical Stitching.
- ☐ Single Cycle Up-Cut Shears.
- ☐ Heavy Duty Rubber Covered, Brick Lined Steel Tanks.
- ☐ Magnetic Loop Control for Acid Tanks.
- ☐ Fume Exhaust System—Roto Clone Scrubber.
- ☐ Automatic Control System for Temperature and Acid Proportioning.
- ☐ Side Trimmer with Scrap Cutting or Balling.
- ☐ Up-Coiler with Strip Oiling System.
- ☐ Entry and Exit Coil Conveyors.

**The Youngstown Foundry & Machine Co.** F&Y

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

*Youngstown, Ohio*

9

## SOLDERING ARMATURE COIL LEADS

# without a Soldering Iron?

Soldering armature coil leads to risers with National-designed induction heating equipment in the National plant.

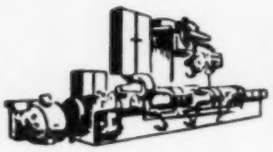
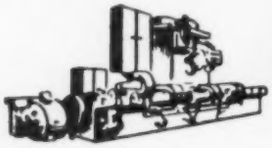
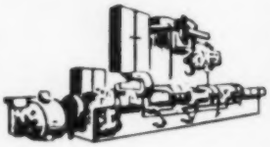
Soldering armature coil leads to risers by hand leaves a lot to the human element. So three years ago, National developed a way to solder by induction heating. It's quicker. More uniform. *Reduces liability of premature trouble.* If you've wondered why a motor or generator repaired or redesigned by National gives such excellent service . . . it's the "little" things like this which National does, unheralded and unsung, that count so much. They mean a lot *in the long run.* Use National coils and engineering service for the unannounced advances which add so little to cost, so much to value.

*Wherever you are our nearby Field Engineer is available*

VISIT US AT BOOTH 1327,
PLANT MAINTENANCE SHOW, CLEVELAND, JANUARY 19-22.

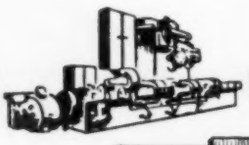
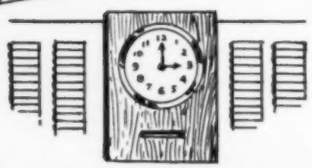
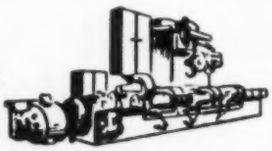
NATIONAL ELECTRIC COIL COMPANY
COLUMBUS 16, OHIO, U. S. A.

ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION—
REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

# GUIDE PRODUCTION  GUARD COSTS  WITH ENLARGED BATTERIES OF BONNOT  BILLETEERS . . .

Those who *guide production* and *guard costs* in the basc processing of quality steels are building up their batteries of Bonnot Billeteers. In fact, because of rugged reliability established over years and years of service, many big companies that already are "multiple users" are further expanding Billeteer facilities.

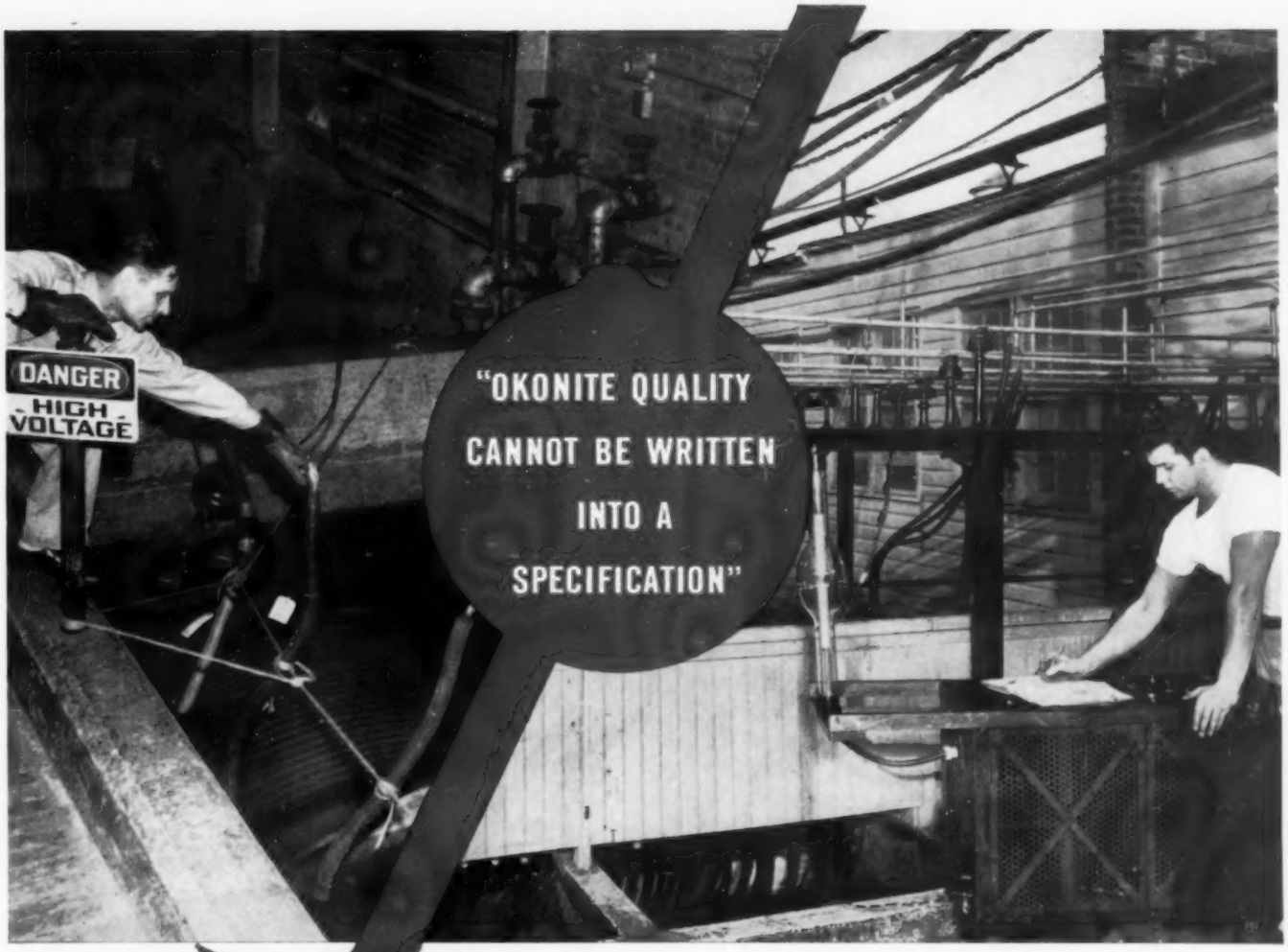
With labor costs irresistibly climbing in your billet-cleaning, as in other phases of production, there is strongly-increased incentive for the kind of smooth, profit-making mechanization that flows from the wider use of the Bonnot Billeteer.

**TIME IS MONEY** **ANY BILLETEERS**  **INSTALLED — SINGLE OR MULTIPLE — WILL CUT TIME**  **CUT COSTS** **CUT LOSSES** **CUT MANPOWER** **TURNOVER PROBLEMS. WHY NOT VIGOROUSLY INVESTIGATE THE MERITS OF EARLY ACTION** **TOWARD BETTER BILLET-CLEANING THROUGH BONNOT BILLETEERING?** 

*Engineered For Improved Production*

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO

Also Manufacturers of — SAWING • PULVERIZING AND MIXING EQUIPMENT • BILLET INSPECTION TABLES
CRUSHING • DUST PUG MILLS • SINTER PLANT PUG MILLS




# Specify Okonite by name

Electrical specifications should be written to cover your particular needs, plus an adequate margin of safety. In the case of electrical wires and cables for critical circuits—circuits which *must not* fail—you can be assured of Okonite quality only by specifying Okonite by name.

Okonite quality—that *extra margin* of circuit dependability—cannot be written into a specification. That's because Okonite quality is represented not by any one material or manufacturing technique, but by a vast background of accumulated research, proof-testing and on-the-job experience.

Take Okolite-Okoprene cable, for instance.

Together, the basic Okolite insulation and the Okoprene sheath are the result of an intensive research program and service experience extending back approximately twenty-five years.

Insulation and sheath of Okolite-Okoprene cables are applied by Okonite's exclusive strip process, a cable-making technique used by no other manufacturer in regular production. Only with this process can uniformity and stability be assured.

Ultra-high voltage testing, the highest in the industry, safeguards Okolite-Okoprene against even the slightest imperfections. And of course Okonite's on-the-job performance record has been documented by utilities and industrial plants throughout the country, time and again.

All these "plus" values are obtainable only in Okonite cable. That's why so many cable buyers today make it a point to specify Okonite by name. The Okonite Company, Passaic, N. J.

*The best cable is your best policy*

**OKONITE** SINCE 1878 *insulated wires and cables*

1163

*For peak performance..*

# choose the control that suits *your furnace*

**FOR STRAIGHT LINE TEMPERATURE RECORDS** *like this*

**When heat input should vary like this...**

**...choose Electr-O-Line**

**ELECTRIC PROPORTIONAL CONTROL**

This position-proportioning control throttles the fuel valve in exact response to changes in heat demand . . . provides proportional action for quick correction of temporary upsets, plus automatic reset to take care of changes in load, fuel pressure, etc.

**When heat input should vary like this...**

**...choose Electr-O-Pulse**

**ELECTRIC PROPORTIONAL CONTROL**

Applicable to electric furnaces and to many fuel-fired units, this control delivers full heat input in pulses . . . varying the ratio of "heat on" to "heat off" time to control average input. It incorporates both proportional and reset actions.

. . . *choose* Manual Reset Control *for less critical applications; has position-proportioning action with manually operated reset.*

* *The difference in control action lies in this relay . . . an integral part of the ElectroniK Controller.*

*

Whatever your type of furnace, Honeywell electric proportioning control will assure top quality performance and maximum output. Independent tuning adjustments, space-saving installation, plug-in construction, and approach rate adjustment are but a few of their plus values.

Your local Honeywell engineer will be glad to recommend the right control for your furnace. Call him today . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4464 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

*First in Controls*

● *Important Reference Data*

**Write for Catalog 15-15, "*ElectroniK* Potentiometers with Electric Proportioning Control".**

# Personnel News...

**A. G. Patterson** was elected president of Electric Controller & Mfg. Co., Cleveland, Ohio, to succeed **R. G. Widdows** who was named chairman of the board. **Dr. John D. Leitch** was elected vice president and chief engineer and **Keith C. Moore** was elevated to treasurer and **Harold J. Rathbun** was made secretary. Officers reelected include **A. C. Dyer,** vice president sales; **N. R. Richardson,** vice president and works manager, and **Miss Gertrude H. Keefe,** assistant secretary. Mr. Widdows joined the company in 1909 as a salesman. In 1924, he was made sales manager and a director. He was elected vice president in 1925 and moved up to the presidency in 1943. Mr. Patterson joined E. C. & M. in 1944 as secretary-treasurer, coming from Tubular Alloy Steel Corp., Gary, Ind., where he was secretary-treasurer. Dr. Leitch went to E. C. & M. in 1937 as head of the development laboratory and was made chief engineer in 1943, a post he continues to hold. Mr. Moore went to E. C. & M. in 1945 as chief accountant, while Mr. Rathbun has been with the company since 1935 as patent engineer, a position he will retain.

**Joseph P. Somers** has been appointed assistant to the president of Wyckoff Steel Co. He formerly was assistant to the vice president in charge of the company's eastern region in Philadelphia, Pa. In his new position Mr. Somers will maintain headquarters in the company's home office at Pittsburgh, Pa.

**W. L. Newhall** has just been appointed director of the department of research and development for Dravo Corp. Named as assistant directors were **C. R. Horton, Jr.,** and **A. J. Liebman.** Mr. Newhall has been with Dravo Corp. since 1925. Before his new appointment, Mr. Newhall was assistant general manager of the corporation's engineering works division.

**M. R. Brice** has been named division manager, industrial control sales for Cutler-Hammer, Inc., Milwaukee, Wisc.

**Kempton Dunn** was elected first vice president of American Brake Shoe Co., New York, N. Y., **William B. Jordan** was named treasurer, **Robert Watts** and **Owen B. Cottle** were made assistant treasurers. Dr. Dunn was formerly vice president and treasurer.

**George W. Knotts,** director and machinery consultant of United Engineering and Foundry Co. has retired. Mr. Knotts, one of the oldest members of United, has served the company for 53 years.

**Robert L. Halsted** has been appointed manager of Allis-Chalmers central region with headquarters in Cleveland, Ohio. Mr. Halsted succeeds **P. F. Bauer,** recently named general manager of the company's Norwood, Ohio, works, and manager of the apparatus department. Mr. Halsted has been with Allis-Chalmers since 1935 and manager of its Cleveland district office since 1948. He was a representative in the company's Cincinnati, Ohio, office for a number of years before becoming manager of the Charleston, W. Va., office in 1942. **Joseph Bronaugh,** manager of the Miami office since 1946, succeeds Mr. Halsted as manager of the Cleveland district office. Mr. Bronaugh joined Allis-Chalmers in 1929.

**Cecil R. Pond,** franchise representative for the Automatic Transportation Co., has formed a partnership, the Pond-Halfacre Co. Joining Pond as partner in the reorganization is **I. L. Halfacre.** Territory includes Alabama and the northwestern part of Florida. Headquarters are at 1723 Lomb Ave., Birmingham, Ala.

**Fred Henning** has been named general sales manager of USCO Power Equipment Corp., Birmingham, Ala. Since 1946 Mr. Henning has been employed as sales engineer, specializing in the sale of heavy equipment, serving the iron and steel industry.

**Fred C. Baldock** has been appointed manager of industrial engineering of Blaw-Knox Co., Pittsburgh, Pa. In his new position, Mr. Baldock will be responsible for the development of industrial engineering objectives, policies and programs for the company's industrial products group (covering eight manufacturing divisions of the company).

**Robert H. Fox** has been appointed sales director of the new crane and shovel equipment division of Cook Bros. Equipment Co., Los Angeles, Calif.

A. G. PATTERSON

JOSEPH P. SOMERS

W. L. NEWHALL

M. R. BRICE

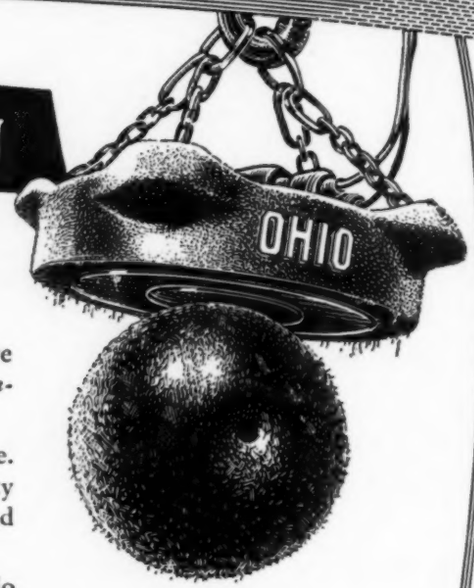
JOHN B. HARMON

**John B. Harmon,** after 24 years service, has retired from the headquarters staff of the Association of Iron and Steel Engineers, Pittsburgh, Pa. For many years, Mr. Harmon has been exhibit manager of the Iron and Steel Exposition in addition to other staff duties. In this work, he has built up a host of friends in the iron and steel and allied industries. A pioneer in the formation of the National Association of Exhibit Managers, he was recently elected an honorary member of that organization in recognition of his efforts, through the years, to better the management of trade shows throughout the nation. Born July 30, 1876 in Warren, Ohio, Mr. Harmon was educated in Warren public schools, Mount Hermon Preparatory School in Massachusetts, and Denison University in Ohio. Prior to his joining the AISE staff on October 15, 1928, Mr. Harmon was employed by American Railway Express Co., Osborn Engineering Co., Pittsburgh Testing Laboratory, Robert W. Hunt Co., Toledo Furnace Co., New York Public Service Commission, McKenna Brothers Brass Co., Vanadium Alloy Steel Corp., and Braeburn Alloy Steel Corp.

**Harry T. Brunstetter** has been named superintendent of the silicon strip department, Republic Steel Corp., Warren, Ohio. Mr. Brunstetter has been with Republic since 1928 and has served successively as tin strip operator, steckel mill and furnace foreman, copper plating foreman, and general foreman of silicon strip. **William E. Schnitgen,** since last November lubrication engineer for the Warren, Ohio, district of Republic Steel Corp., succeeds Mr. Brunstetter as assistant superintendent


HEAVIER CONSTRUCTION

another reason why
OHIO is the *PREMIER* mill magnet




In skull cracker service—or any use where magnets are subjected to hard knocks—you need the *extra heavy construction* of Ohio Magnets.

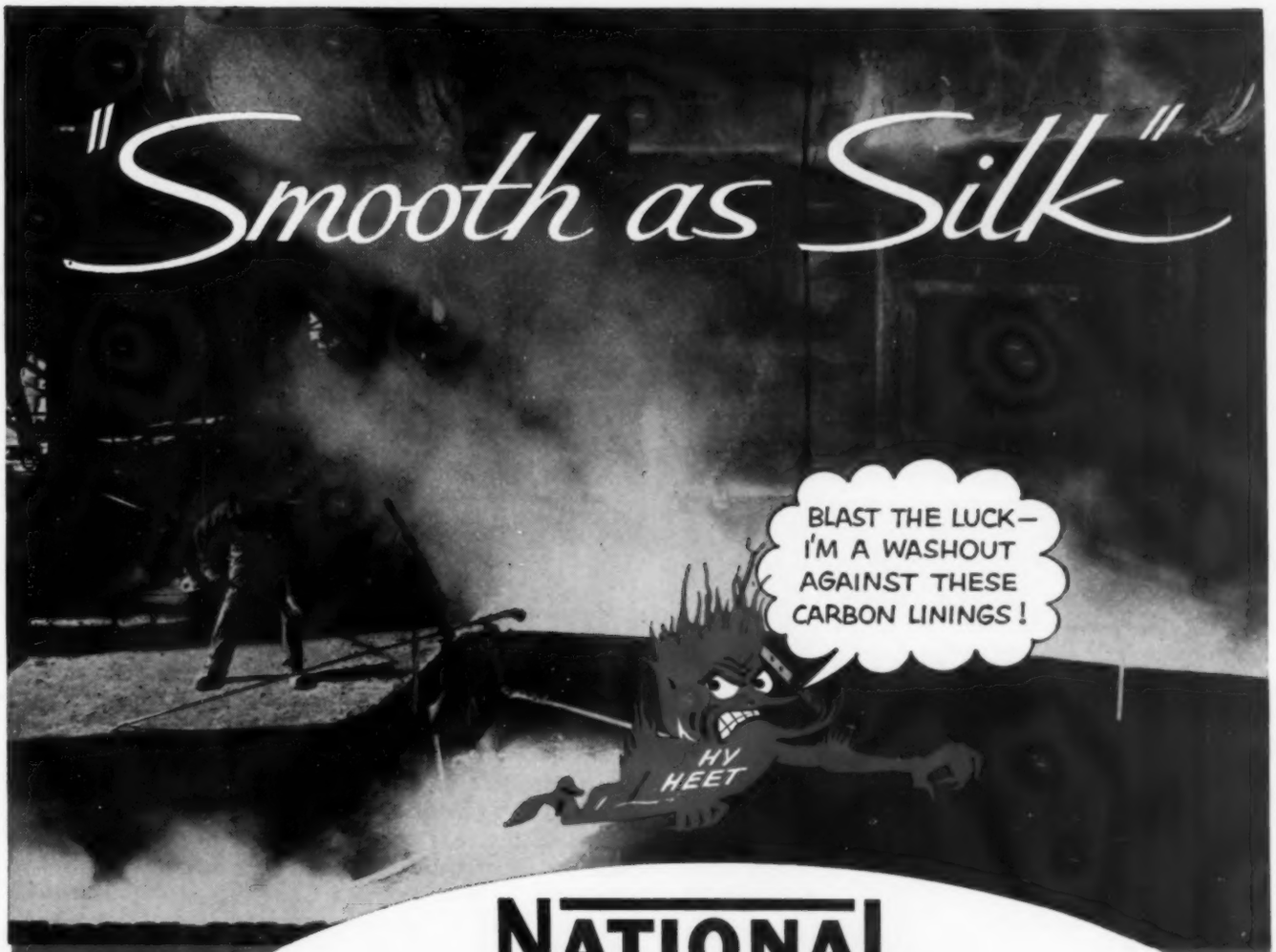
Take a look at this Ohio Basket Magnet, for instance. In addition to extra heavy top and bottom plates, hefty fenders project beyond magnet diameter . . . stave off and protect against damaging blows.

For extra magnet life, extra magnet value—specify Ohio Magnets. And remember, *Ohio Magnets lift as much or more than other magnets of the same size.* A-5388

THE OHIO ELECTRIC MFG. CO. • 5900 MAURICE AVENUE • CLEVELAND 4, OHIO

CHESTER BLAND
President

Ohio ELECTRIC




# NATIONAL
TRADE-MARK

## CARBON-LINED BLAST FURNACES

TYPICAL of the many comments favoring carbon-lined furnaces after the recent strike, was that made by the manager of a large eastern mill.

Describing his carbon hearths as coming back on blast "smooth as silk", he joins the many other users reporting faster, easier, more economical return to normal operation with carbon lined furnaces than with any other type of lining.

**MORE THAN 30% OF ALL U. S. BLAST FURNACES ARE NOW LINED WITH "NATIONAL" CARBON!**

*The terms "National" and "Eveready" are registered trade-marks of Union Carbide and Carbon Corporation*

**NATIONAL CARBON COMPANY**
**A Division of Union Carbide and Carbon Corporation**
***30 East 42nd Street, New York 17, N. Y.***

*District Sales Offices:* Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
IN CANADA: National Carbon Limited, Montreal, Toronto, Winnipeg

***DOLLARS and SENSE...***

point to "Eveready" No. 1050 Industrial Flashlight Batteries . . . delivering twice as much usable light as any battery we've ever made before. Their unique construction prevents swelling or jamming in the case . . . has no metal can to leak or corrode.

OTHER **NATIONAL CARBON** PRODUCTS

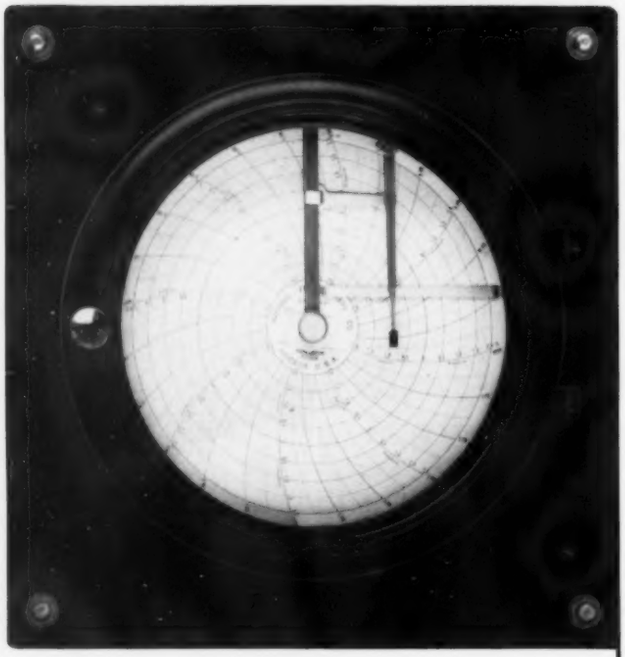
BLAST FURNACE LININGS • BRICK • CINDER NOTCH LINERS • CINDER NOTCH PLUGS • ELECTRIC FURNACE ELECTRODES • SPLASH PLATES • RUNOUT TROUGH LINERS • MOLD PLUGS

# accurate— sensitive— trouble-free— easy to service—

## Four reasons for choosing these Republic Low Pressure Instruments to measure flow or pressure of gas and air

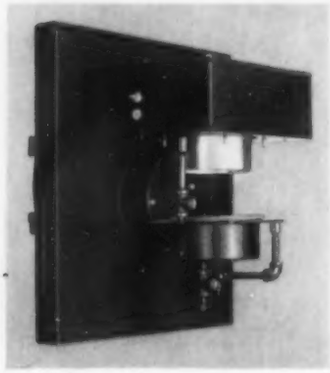
## in

OPEN HEARTH FURNACES
SOAKING PITS
REHEATING FURNACES
COKE OVENS
SMELTING FURNACES

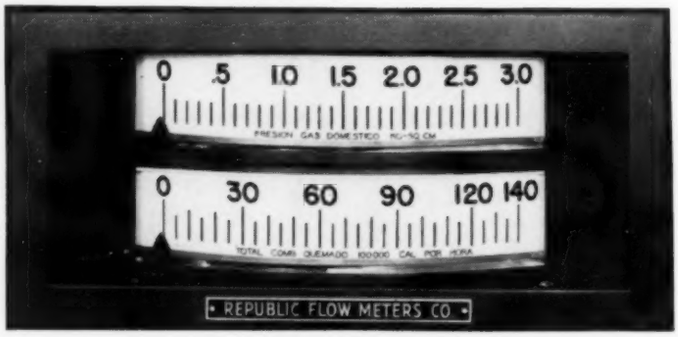


Republic Oil Sealed Bell Recorder at left responds to the slightest changes in furnace pressure and stack draft, and works independently of other controls. Operating principle is so simple that a minimum of maintenance is required. Sealed bell withstands high temperatures and will not crack, rupture or wear out. For pressure or vacuum measurement, the Recorder may be connected directly to a furnace or pipe line. For differentials, it may be connected across an orifice.

Recorder has ranges 0-0.2″ $H_2O$ and 0-8″ $H_2O$ at static pressures to 10 psi. On low range, large 4″ diameter bell gives sensitivity of ±.001″ $H_2O$.



For quick periodic inspection and cleaning, mineral oil reservoir at rear of Recorder may be lowered by disconnecting one pressure connection and four bolts. Calibration is not changed.




Horizontal Indicator is operated by a tough, resistant diaphragm made of polythylene plastic. Each Indicator is separate and may be individually removed or adjusted. Indicator arm swings on jeweled bearings for friction-free accuracy. Internally illuminated scales may show pressure, draft, pressure-draft combination or differential pressure. Ranges from 0-0.2″ $H_2O$ to 0-40″ $H_2O$.

Two Indicators are often mounted together to read air flow—gas flow ratio in furnace firing. They may be calibrated so their pointers line up when air and gas are in the correct ratio.

Both instruments fully described in Bulletin 802. Write for your copy today.

**REPUBLIC FLOW METERS CO.**
**2240 Diversey Parkway, Chicago 47, Illinois**

of the silicon strip department. He joined Republic as a technical operating trainee in 1948 and served as assistant mechanical foreman before assuming duties as lubrication engineer. **P. R. Cleary,** formerly of Republic Steel Corp., Warren, Ohio, district's industrial engineering staff, has been advanced to the post of lubrication engineer.

**Charles W. Dunn** has been made technical coordinator, maintenance and utilities division at the Fairless works, of United States Steel Co. at Morrisville, Pa. Prior to joining the Fairless works as general supervisor-installation a year ago, Mr. Dunn worked as project engineer in charge of rebuilding the paperboard mills at the Ohio Boxboard Co. Previously, he was design engineer and machinery inspector during the construction of No. 4 seamless mill at the Lorain, Ohio, works of National Tube division, and special engineer (mechanical) at the Duquesne, Pa., works of United States Steel.

EMERY B. KEREKES

**Emery B. Kerekes** was named assistant to the vice president of Hydropress, Inc. and its subsidiary, The Loewy Construction Co., Inc. of New York, N. Y.

**Carl E. Johnson** has been appointed chief engineer of the Scaife Co., Oakmont, Pa. For the past 19 years Mr. Johnson has been an engineer for this company.

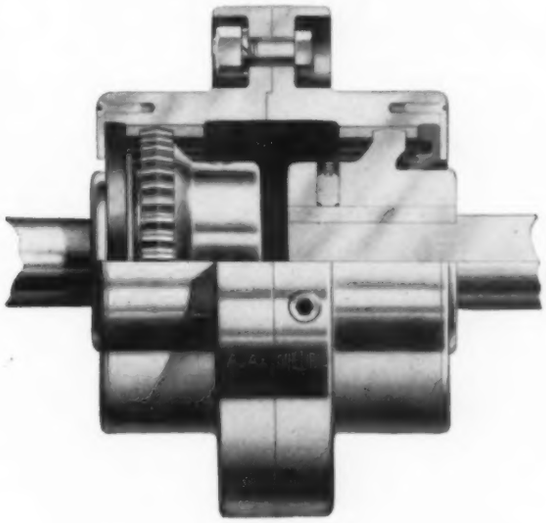
**James M. Mead,** formerly manager of the New York, N. Y., plant of Joseph T. Ryerson & Son, Inc., steel distributors, has been appointed first assistant to Ainslie Y. Sawyer, vice president in charge of purchasing, procurement and merchandising. His headquarters will be in Chicago, Ill.

**Walter H. Wiewel,** vice president in charge of sales, Crucible Steel Co. of America, and **Rowland H. Coleman,** vice president and director of sales, Remington Arms Co., were elected to the board of directors of Rem-Cru Titanium, Inc., Midland, Pa.

**Frederick E. Wenzel** was appointed general manager of Trent Tube Co., East Troy, Wisc. Mr. Wenzel had been works manager of Trent Tube since 1949.


AJAX DIHEDRAL

**FLEXIBLE COUPLINGS**
***Provide for and Protect Against Excessive***
**MISALIGNMENT**



▶ Mill service breaks the heart of men who use ordinary couplings. Ajax Dihedral Couplings are saving thousands of hours and dollars by eliminating the necessity for precision alignment of motors and other equipment. Change-overs made in minutes instead of hours.

Stock couplings delivered off the shelf to handle misalignment up to 4 degrees. 6, 8, 10 and 12 degree couplings cut to order.

Write for the facts,—experienced coupling specialists in the field give personal service.

**AJAX FLEXIBLE COUPLING CO. INC.**
WESTFIELD, NEW YORK

30% Less Space
Same High Capacity
IN NEW
LINTERN
MODEL 531
CAB UNIT

The new Lintern Model 531 CAH Cab Unit now available with the Lintern Aire-Rectifier for hot metal cranes furnishes comfortable year 'round air conditioning — with greater visibility than ever.

Dimensions have been cut down to 36" H. x 17" D. x 28" W. Thirty per cent less space required!

Performance characteristics are of the same high standards as in previous models, providing three capacities, 14,000 b.t.u., 18,000 b.t.u. and 27,000 b.t.u. at 140° F. The quiet blower allows for complete air direction and deflection as the operator desires. The unit maintains the cab at a cool, comfortable 80-85° F. in ambient temperatures up to 180° F. and filters the air of dusts and waste gases.

THE LINTERN CORPORATION
P. O. Box 428 • Painesville, Ohio

**Theodore J. Kauffeld,** president of Devenco, Inc., New York, N. Y. since 1944, has been elected to the newly created position of chairman of the board and the corporation's chief executive officer. **George H. Kauffeld, Jr.,** executive vice president and general manager for the last 18 months, has been elected president of the company.

## *Obituaries*

**Harry Dobrin,** 68, nationally known in the field of combustion engineering and president of Furnace Engineers, Inc., Pittsburgh, Pa., died October 25.

HARRY DOBRIN

**William Ray Culbertson,** 62, a vice president of the Rust Furnace Co., Pittsburgh, Pa., died October 29. Mr. Culbertson was in business in Mt. Vernon, Ohio, before joining Rust Furnace, a subsidiary of the Rust Engineering Co., as general manager in 1932. He was elected a vice president in 1945.

**Walter Hildorf,** 68, formerly director of metallurgy at Timken Roller Bearing Co., died in Lansing, Mich., on October 3.

**Frank Cordes,** 82, former chairman and president of the Blaw-Knox Co., Pittsburgh, Pa., who ended almost a half-century of active business when he retired in 1946, died October 20.

**John R. Lewis,** 69, formerly Pittsburgh, Pa., district manager of Crocker-Wheeler Electrical Manufacturing Co. (now a division of Elliott Co.) died October 16. Mr. Lewis had retired in 1950.

**Fred H. Haggerson,** 68, chairman of the board of Union Carbide and Carbon Corp., died October 14 in New York, N. Y. Mr. Haggerson, who had been with Union Carbide for over 33 years, became chairman of the board in 1951. He had been made vice president of the corporation in 1938.

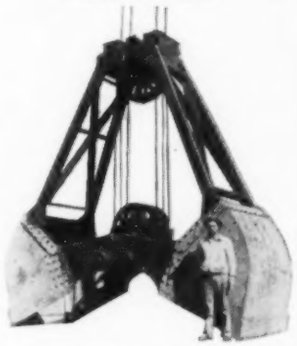
## Wellman will build it

Special Cranes
Ore Bridges
Gas Producer Plants
Charging Machines
Forging Manipulators
Car Dumpers
Gas Flue Systems
Gas Reversing Valves
Coke Pushers
Mine Hoists
Skip Hoists
Clamshell Buckets

# Wellman ore and coal handling bridges

give fast and efficient operation

*One of two 6-ton Coal Handling Bridges in this installation.*



*6-ton Wellman Williams Type Coal Bucket used with these bridges.*

● Take advantage of Wellman's long experience in designing and building handling bridges of many types and capacities. Your selection from the complete line will provide fast and efficient handling of coal or ore. Wellman equipment, in service the world over, is recognized for its long life and dependable service. It is backed by more than half a century of engineering experience.

**THE WELLMAN ENGINEERING COMPANY**

7000 CENTRAL AVENUE • CLEVELAND 4, OHIO

# Take it, with our compliments...

## this new engineering data book on thermocouples

You need this up-to-the-minute 56-page edition of Bristol's famous book if you're involved with thermocouples and pyrometers of any kind. It's free for the asking. Here's what you get in its three, fact-packed sections . . .

**1. You get a User's Manual**...filled with data you'll constantly refer to for the right thermocouple and protection tube for every purpose. Included are tables, charts, etc., on Factors Affecting Thermocouple Life, Corrosion and Poisoning, Thermocouple Reproducibility, Proper Location and Installation of Thermocouples, etc.

**2. You get a Buyer's Guide**...a complete catalog listing assembled thermocouples and replacement parts for all standard installations (special uses, too) . . . with full specifications, prices, illustrations so handily indexed ordering's a cinch.

**3. You get Thermocouple Calibration Data** ...complete, easy-to-use tables of calibration data for all commonly used base-metal and rare-metal thermocouples.

**Make sure you get your free copy now!**

# BRISTOL

*The dependable Guidepost of Industry*

**AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS**

**THE BRISTOL COMPANY**
**123 Bristol Road**
**Waterbury 20, Conn.**

Please send free book on Bristol Thermocouple and Pyrometer Accessories.

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COMPANY_____

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# TRANTINYL

## guides the steel industry

**YOUNGSTOWN ALLOY CASTING CORP., • YOUNGSTOWN, O.**

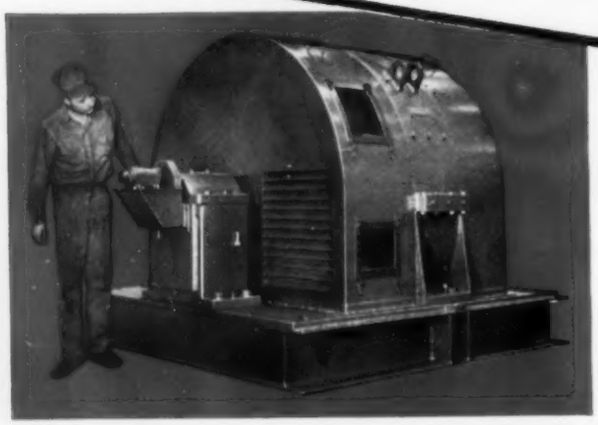
ROLLING MILLS: bar, hoop, strip, shape mill guides, and rollers. SEAMLESS TUBE MILLS: guide shoes, rolling mill plugs and rolls, piercer points, etc. ELECTRIC WELD TUBE MILL: forming rolls, planishing rolls, tool holders, etc. • STRAIGHTENING MACHINE GUIDES • HEAT RESISTING CASTINGS

ANOTHER* EXAMPLE OF ELLIOTT Excellence IN MOTORS

# * SILVER BRAZING

## . . . for permanence in many joints and connections

■ By many tests silver alloy brazing has been proved to make joints that are stronger than the metal parts being joined. It is used in Elliott motors and generators in all joints where permanence and the maximum conductivity of an enduring bond are essential. Below is shown the process of silver brazing the compensating winding joints in a large direct-current motor. The compensating winding—first developed by Elliott Ridgway Works in 1895—consists of copper bars insulated with mica, inserted in slots in the pole faces.



SHOWN AT LEFT is the completed Elliott 800 hp, 175/350 rpm, 600 volt D-C mill type motor with force ventilation covers and tachometer generator. This motor drives a Bliss reversing strip mill.

*For full details on this and other Elliott motors, contact your local Elliott representative or write Elliott Company, Ridgway, Pa.*

**ELLIOTT Company**

**RIDGWAY DIVISION**

*ELLIOTT ELECTRICAL EQUIPMENT INCLUDES CROCKER-WHEELER INDUSTRIAL MOTORS*

R2-14

# Publication Service...

*NOVEMBER, 1952*

**You Can Obtain...**

*... any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.*

**(1) Zeolite Softener**

Just issued is a revised edition of a bulletin on sodium zeolite softeners. The bulletin gives a detailed explanation of zeolite water softening, including a glossary of terms used in the process, data for laying out a zeolite softening plant, the factors governing the size of equipment, the selection of zeolite materials and a detailed description of the four stages of operation of a sodium zeolite softener. A complete description of the hydromatic single control valve is included. This single control valve is six individual valves in one, replacing the usual "valve nest," operating easily and effectively, either manually or when arranged for automatic operation. (4520-A). Cochrane Corp.

**(2) Hydraulic Lift Trucks**

A bulletin just released presents hydraulic lift trucks which fit into the current trend to move materials and goods in larger loads — a logical remedy for the increased cost of man-hours. These new hydraulic lift trucks have been designed for the easier and safe one-man handling of heavy skid and box loads. Operation is quite simple. The operator merely guides the platform of the truck under the skid and lifts the load to travel height with as few or as many strokes of the handle as desired; long strokes for a quick lift or short strokes for a heavy load. The handle can be dis-engaged from its normal upright position and made ready for towing by pressing the thumb handle release. To lower the load, operator steps on treadle and the load is gently lowered to the floor. A 6-in. lift is standard for these trucks. Three standard models are shown: ED with 2500 lb capacity; LD with 4000 lb capacity; and MD with 6000 lb capacity. The bulletin contains complete specifications, and also ordering information which explains all figures in the specifications. (525). Barrett-Cravens Co.

**(3) Air Conditioning**

A 60-page catalog of Westinghouse-Sturtevant products for "putting air to work" is now available. The two-color general product and application catalog is divided into three sections: one, a 21-page equipment section; two, a 14-page "putting-air-to-work" application section; and three, a 16-page engineering data section. A "Quick-Finder" chart greatly simplifies the problem of selecting the right piece of equipment for the job; it does this by cross-indexing equipment performance and job requirements. On the same page is a "Quick-Finder" index integrated with the "Quick-Finder" chart. Section one — the equipment section — is the most complete and up-to-date set of condensed specifications, dimensions, and descriptions of Westinghouse-Sturtevant products yet published. Section two — the well illustrated, application section — tells how to put air to work by relating equipment capabilities to the job requirements. Section three — the engineers data section — is a collection of tables, charts and useful data that can be used to determine the correct Westinghouse-Sturtevant product for a given job of air handling, air conditioning, and air cleaning. (600). Westinghouse Corp.

**(4) Motor Case Histories**

Over 100 case histories of outstanding applications of "Life-Line" motors are depicted in a new 35-page booklet available to you. Picked from the more than ¾ million "Life-Line" motor applications in existence today, these case histories represent practically every phase of industry. Included are actual applications in the chemical, textile, petroleum, lumber, metalworking, paper, food, mining, and machine and production tool industries. Most of the histories are illustrated — either with photographs or sketches — and each gives the particular application problems involved, the motor choice for the job, and the results. In more than half the cases, the geographic location, and the user's name are included. (B-4769). Westinghouse Electric Corp.

**(5) Direct-Fired Furnaces**

A new bulletin on direct fuel-fired furnaces for all types of heat treat processing has just been released. Practical applications of direct fuel-fired batch and continuous furnace designs in the ferrous and non-ferrous industries are shown, and basic operating data given for each of these typical examples. General information is also included on the possible applications of convection heating and the utilization of auxiliary materials handling systems. (SC-156). Surface Combustion Corp.

**(6) Check Valves**

A new 2-page bulletin fully describing hydraulic double cushioned check valves is available. Two detailed drawings show the complete list of parts. The application, construction, sizes and pressures are fully described along with tables showing general dimensions and figure numbers. (WS-1). Golden-Anderson Valve Specialty Co.

**(7) Nickel Plated Metals**

High corrosion resistance giving nickel plated metals wide range of uses is the subject of a bulletin that points out that nickel plating can often be the economical answer where service conditions do not justify use of solid corrosion resistant materials, because of nickel's good corrosion resistance to a wide variety of products. Various industrial examples show nickel successfully plated on cast iron, steel, bronze and copper equipment. Deposits as thin as 0.003 and as thick as 0.080 in. prevent product contaimination and equipment deterioration and reduce maintenance. International Nickel Co., Inc.

### (8) Die Block Handbook

Publication of a new and enlarged edition of the "Die Block Handbook" has been announced. The 80-page booklet describes eight types of Heppenstall die steels and tells the recommended application of each. Pre-hardened steels are "Hardtem," "Prestem," "Pyrotem," and "Thermotem." Steels of the same chemistry, furnished in the annealed condition, are known as "C-Annealed," "Presneal," "Pyroneal," and "Thermoneal," respectively. Detailed instructions for heat treatment of the annealed steels are given. Other products described include sow blocks, hammer rams, piston rods and heads, trimmer steels, and crank and eccentric shafts for forging machines. The products are illustrated by photographs, and, in addition, a number of diagrams are used. The book includes many helpful tables, such as comparative hardness, draft angles for die blocks, a shrink chart, decimal equivalents of fractions, a temperature conversion chart, die block weights, and weights of various shapes of steel bars.

### (9) Salt Bath Furnace

Seventeen ways in which the submerged electrode salt bath furnace can increase metal heat treating efficiency on 10 specific heat treating applications in the temperature range from 1100 F to 2400 F are described in a new bulletin available to you. Recently introduced, the submerged electrode furnaces are a logical addition to the line of suspended electrode furnaces pioneered by this firm, and widely used throughout the industry for a variety of heat treating applications. (123-B). Ajax Electric Co., Inc.

### (10) "How to Enclose Heat"

That is the subject of a new booklet which goes back into history to outline the development of the "Art of Enclosing Heat." Under such headings as "Origin of the Arch," "Flat Suspended Arch," "Sectionally Supported Walls," the important steps in evolving the present designs are covered.

The center section shows how the knowledge gained from nearly a half century of experience is applied to specific heat enclosure problems in various industries.

Graphs and tables are presented which help to select the proper type of construction for any combination of heat and operating conditions.

The third section describes a variety of modern heat enclosure constructions which may be applied to present day units as well as many units still to be developed.

Under the title, "Heat Enclosure Methods," is a work that will serve as a textbook on the subject of enclosing heat (with refractory walls and arches) for years to come. M. H. Detrick Co.

### (11) "Write On It" Tape

Folder in four colors tells the whole story of Labelon, the newly developed pressure sensitive plastic tape "you can write on." Pictures and descriptive material show many of the 1001 uses of this unusual new labeling aid, and an actual sample attached to the folder shows how Labelon may be applied to any smooth surface, written on with pencil, stylus or dry ball point pen, and how it is resistant to dirt, oil, water, acid and unaffected by temperatures from -40 to 160 F. Data on the many colors and widths is included, as well as roll lengths and types of dispensers for use with the various rolls. (8). Labelon Tape Co., Inc.

### (12) Outdoor Splashproof Motors

Elliott Co. has published a new four-page illustrated bulletin describing its complete line of outdoor splashproof (weather protected) "Fabri-Steel" induction motors ranging in size from 250-4000 hp, 2 poles; 50-3000 hp, 4 to 14 poles. The bulletin includes an explanation of the carefully engineered Elliott ventilation system which culminates five years of pioneering in outdoor motor design. Simplified maintenance and other improved design features made possible by the Elliott fabricated steel construction are fully described and illustrated. (PB-7000-3). Ridgway Division.

### (13) Protective Coatings

A forty-four page catalog entitled "Insul-Mastic In Industry" has just been published by the Insul-Mastic Corp. of America. This company manufactures Gilsonite base protective coatings, and the new book describes these coatings, their properties, their uses and tests to which they have been subjected. Related products such as caulking compounds, primers and membraning material are also described since they augment the use of the company's coating. Insul-Mastic coatings are used mainly to prevent corrosion of industrial equipment — especially in chemically contaminated atmosphere; to waterproof buildings and to act as a weather barrier or vapor barrier over thermal insulation. A special cork filled coating is also described in the book. This coating performs the double function of preventing corrosion and insulating. It is recommended for use in the atmospheric temperature range to prevent heat loss or to control condensation. The new Insul-Mastic catalog contains numerous photographs of chemical vessels, industrial equipment and buildings which have been protected by Insul-Mastic coatings. "Insul-Mastic in Industry" is available as a guide to maintenance and for the writing of specifications.

### (14) Oxygen Cutting

"Oxygen Cutting of Defense Equipment Materials" is now available as a reprint (Form ADR 78) it was announced by Air Reduction Sales Co., a division of Air Reduction Co., Inc. This article, which originally appeared in "The Welding Journal" is designed to be of assistance in the development of specifications and procedure control for the proper, economical and accurate cutting of various kinds of steel used for defense equipment materials.

### (15) Dehumidification

The new 1952 edition of a bulletin entitled "A Few Facts About Dehumidification for Industry" is available. This bulletin is written from the standpoint of manufacturers. Those who have problems such as mold, rust, mildew, caking, dripping pipes, wet walls, corrosion, warping, mustiness, etc., will find the information of great value. A few of the subjects covered are: What is meant by relative humidity? What are the signs and results of too much humidity? The booklet tells of the various methods used to remove moisture from the air, some recommended humidities, and, in addition, describes a number of instruments both for general use and scientific purposes to determine the amount of moisture in the air. Abbeon Supply Co.

### (16) Hinged-Steel Conveyor Belt

The availability is announced of a new 4-page illustrated catalog which describes and presents specifications on the recently developed May-Fran hinged-steel belt.

Sturdily constructed to withstand extreme wear, this belting is recommended for handling metal scrap, hot forgings, flash, wet or dry metal chips and turnings as well as other sharp or abrasive materials. It can be assembled in almost any width or length from stocked components to meet the requirements of specific applications. (MF-530). May-Fran Engineering, Inc.

**(17) Fan Catalog**

Just issued is a revised edition of the catalog on "Bifurcator" fans. Specifically designed for exhausting fumes or gases which are abnormally hot, flammable or explosive, the "Bifurcator" is a direct motor driven fan in divided housing, with the motor mounted in a separate chamber isolated from destructive gases. Catalog is profusely illustrated and contains specifications, dimensions and certified capacities of these fans from 12 in. through 48 in. in diameter handling up to 45,000 cmf of air. (DB-4-52). DeBothezat Fans Division, American Machine and Metals, Inc.

**(18) Tri-Rotor Pump**

The publication of a new 38-page catalog on a line of "Tri-Rotor" pumps and the establishment of a "Tri-Rotor" pump repair parts and service center have been announced. The new pump catalog contains information on the various models in the Yale & Towne pump line, ranging from 20 gpm to 200 gpm. The catalog has detailed explanations of the operations of the pumps, descriptive matter on pump accessories, and descriptions of the combinations and permutations which are possible with these accessories. An interesting feature of the catalog is a complete section devoted to engineering data helpful to a prospective user in determining the size of pump to be used and the method of installation. The newly-established repair parts and service center at the Stamford Division will maintain a stock of repair parts, to provide very rapid repair service. A feature of the Service Center will be the rigid test procedure to which each "Tri-Rotor" Pump will be subjected before return to the customer. Stamford Division, Yale and Towne Mfg. Co.

**(19) Advanced Handling Methods**

Cost-conscious warehousing and production executives will find special interest in the account of savings gained through advanced handling methods in a new certified job study just prepared. Adjustments that cut unloading costs as much as 92 per cent for a tobacco manufacturer are detailed in the study. Methods of stacking 1000-lb casks of tobacco to increase storage capacity 65 per cent are graphically reported. Tobacco stems are now loaded for shipment to a manufacturer of by-products at a saving of 89 per cent in man-hours. In the storing of flavoring-sugar, handling costs were slashed 87½ per cent and 10 men released for more productive jobs. Procedure that affected these, and similar high savings throughout the huge tobacco processing plant, are concisely but clearly summarized in the 4-page study. (Certified Job Study 115). Towmotor Corp.

**(20) Scale Catalog**

A new 28-page condensed scale catalog has just been released.

A handy reference featuring the most complete line of modern scales for every industrial need, the catalog includes a selection of a thousand popular standard Howe scales weighing from $\frac{1}{64}$th oz to 400 tons. A compact edition of a complete catalog of 200 pages, the new condensed scale catalog includes complete specifications, spot illustrations, and essential information. A simple index makes it easy to find any scale. The condensed scale catalog is conveniently arranged by types of weight indication. Featured are the famous Howe scales with beam indication, the exclusive tape-drive dial, unique "Weightograph" projection, and the revolutionary "Teleprint" electronic remote weight recorder. The condensed catalog also shows a page of Howe hand trucks, and a listing of its branches with sales and service departments throughout the country. (11). Howe Scale Co.

**(21) Electric Tool Catalog**

Just published is a comprehensive 36-page catalog covering a complete line of multi-cycle electric tools. The catalog is divided into eight sections: "Impactools," nut runners, drills, screw drivers, grinders, buffers, sanders and polishers. Over 100 different sizes are listed covering both 180 and 360 cycle models. Complete lists of equipment and accessories are also included. For a copy of this new multi-cycle electric tool catalog, write the DN number on the post card. (5111). Ingersoll-Rand Co.

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| 51 | ALLIS-CHALMERS MANUFACTURING CO. | BULLETIN 14B6505A | Type 260 DC contactors. |
| 52 | AMERICAN CHEMICAL PAINT CO. | | ACP phosphate coating chemicals. |
| 53 | AMERICAN MANGANESE STEEL DIVISION, AMERICAN BRAKE SHOE CO. | CATALOG 650W | Gives pertinent information on wear problems. |
| 54 | BLOOM ENGINEERING CO., INC. | BULLETIN C-220 | Bloom LP oil burner. |
| 55 | BRISTOL CO. | | Bristol thermocouple and pyrometer accessories. |
| 56 | BRISTOL CO. | CATALOG P1245 | Bristol electronic dynamaster. |
| 57 | BROWNING AND CO., INC., VICTOR R. | BULLETIN "E" | Browning mill type cranes. |
| 58 | DURABLA MANUFACTURING CO. | REFERENCE 2S11 | Durabla valve units. |
| 59 | ELECTRIC CONTROLLER AND MANUFACTURING CO. | BULLETIN 900 | EC&M all welded magnets. |
| 60 | ELECTRIC PRODUCTS CO. | BULLETIN 2-200 | EP electrical rotating equipment. |
| 61 | ELECTRIC SERVICE MANUFACTURING CO. | | Keystone aluminum conductor system. |
| 62 | ELLIOTT CO. | | Bulletin available on mill motors. |
| 63 | FARVAL CORP. | BULLETIN 60 | Farval spray valve. |
| 64 | FOOTE BROS. GEAR AND MACHINE CORP. | BULLETIN HGB | Describes Hygrade worm gear drives. |
| 65 | FURNACE ENGINEERS, INC. | | Bulletin available telling about F.E.I. service — complete from plan to operation. |
| 66 | GENERAL ELECTRIC CO. | BULLETIN GEA-4654 | G-E mill motors. |
| 67 | GENERAL ELECTRIC CO. | BULLETIN GET-1789A | G-E ore-bridge drive. |
| 68 | GULF OIL CORP. | | Gulf periodic consultation service. |
| 69 | HEIL PROCESS EQUIPMENT CORP. | BULLETIN 43-A | Heil steam jet agitators. |
| 70 | HOMESTEAD VALVE MANUFACTURING CO. | REFERENCE BOOK NO. 39 | Describes Homestead valves. |
| 71 | KOPPERS CO., INC. | | Fast's couplings. |
| 72 | LEEDS AND NORTHRUP CO. | FOLDER N-33-640 | Tells how to measure bath temperatures effectively. |
| 73 | LESLIE CO. | | Leslie regulators. |
| 74 | LOVEJOY FLEXIBLE COUPLING CO. | | Lovejoy flexible couplings. |
| 75 | MEDART CO. | | Medart billet peelers. |
| 76 | MINNEAPOLIS-HONEYWELL REGULATOR CO., INDUSTRIAL DIVISION | CATALOG 15-15 | Electronik potentiometers with electric proportioning control. |
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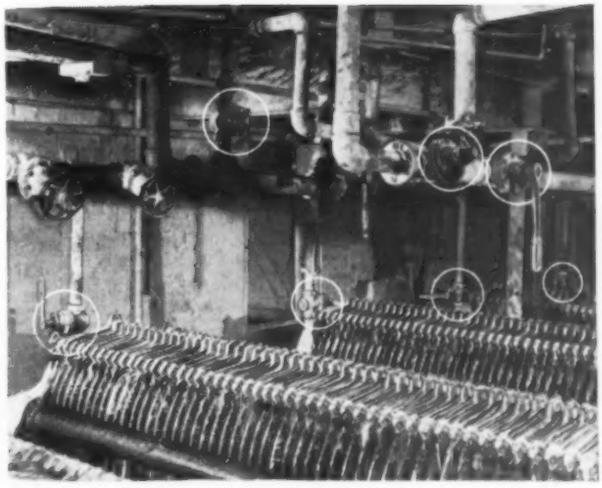

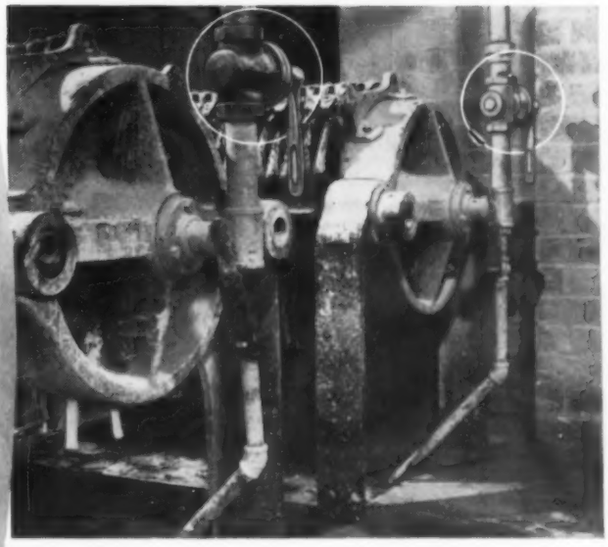

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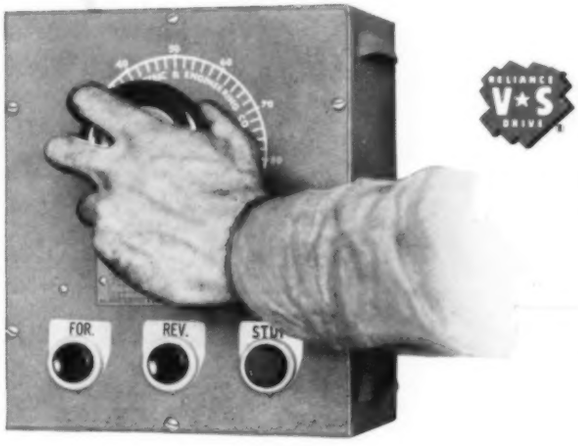


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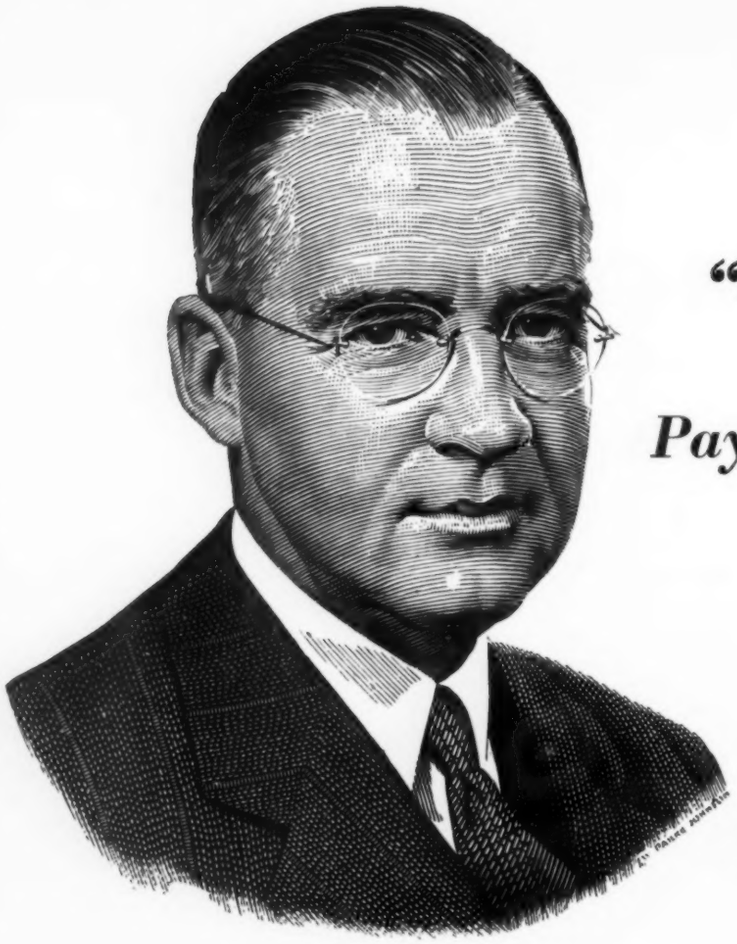

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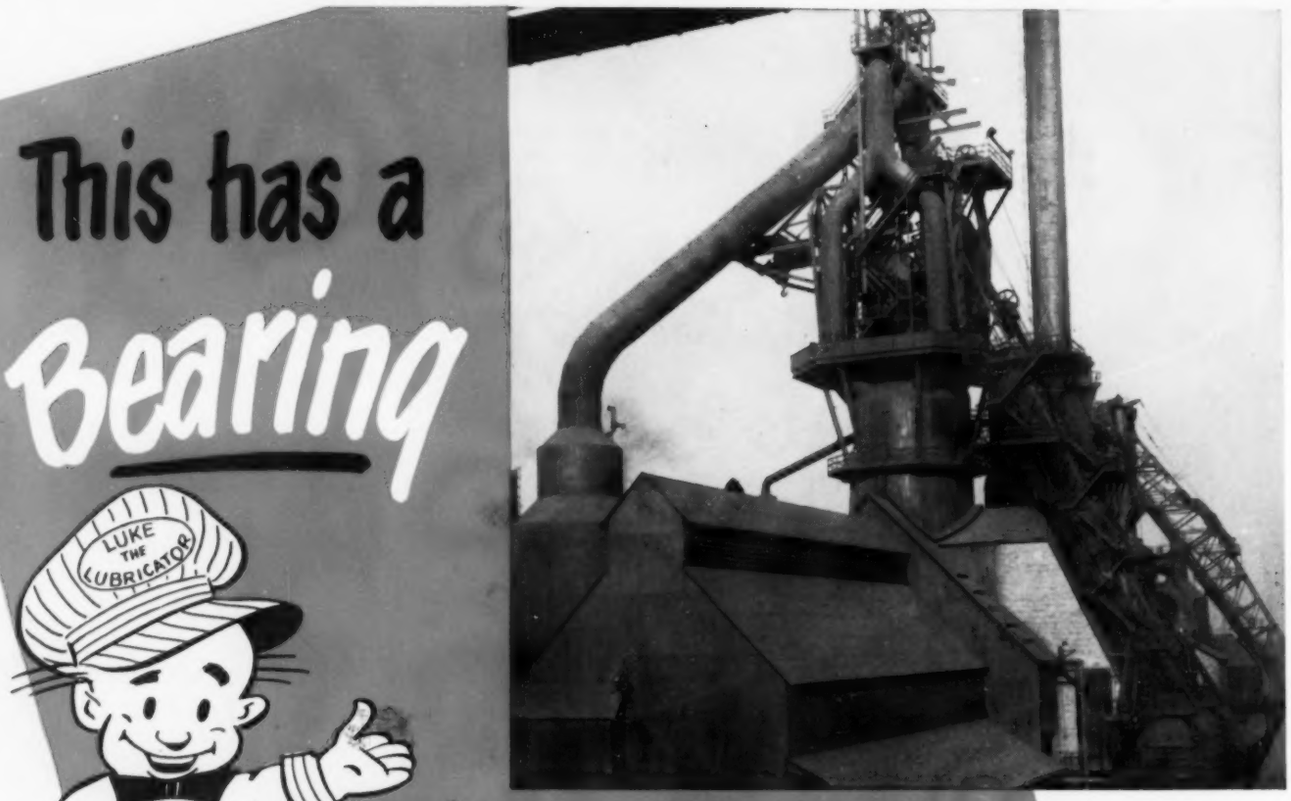

We're conservative. This blast furnace has a lot of bearings . . . bearings which will cost you hard maintenance dollars if they're not properly *lubricated.*

All these bearings can be *automatically* lubricated with a Trabon system. When you install a Trabon system, you don't need to worry about whether the proper amount of oil or grease is being delivered at the proper time.

Completely sealed against dirt.

Size, type, motion or location of a bearing make no difference to a Trabon lubrication system.

Our patented progressive feature guarantees that no bearing will be short-changed. Operation of each measuring valve depends on the previous valve having operated first.

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Get your metalworking bearings on a Trabon Lubrication System . . . complete engineering data or general information in Bulletin 529 are yours for the asking, from our representative near you, or the address below.

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# Equipment News...

## THERMOCOUPLE WIRE

▲ Further economies in consumption of critical materials—and in customer operations—will be introduced in December by Minneapolis-Honeywell Regulator Co.'s Industrial Division. At that time the company will start shipping a smaller gauge weatherproof extension wire for its iron-constantan thermocouples.

Use of the smaller wire makes it possible to increase the total footage of wire which customers may obtain from the alloy alloted to the company. It also enables users to install more wires per conduit.

The smaller gauge wire can be used with all models of Honeywell's electronic instruments, most of which are relatively unaffected by external resistance.

The small-gauge, two-conductor wire is covered with the same type of thermoplastic insulation used for larger gauge wire of the same type. Each conductor is individually coated with polyvinyl chloride $\frac{1}{64}$-in. thick and both conductors are covered over-all with cotton braid impregnated with asphaltic base weatherproof saturant. Color coding will be the same as for the larger gauge; white designating the positive conductor and red the negative conductor.

## OIL BURNER

▲ A new oil burner, employing atomizing air at 16 ounces, has been developed by Bloom Engineering Co., Inc. Providing equal flame characteristics for both oil and gas, the Bloom LP oil burner was designed to provide a solution to four specific problems—those of: (1) getting flows low enough to prevent overriding of temperature, and yet keep the burners lighted; (2) getting wide range turndown, where wide range of fuel input is a must; (3) eliminating intricate adjustments on individual burners; and (4) eliminating the necessity for a separate source of high pressure air for atomizing the fuel oil.

According to the manufacturer, this new burner successfully overcomes all of those problems. It has a minimum flow of less than ½ gphr, and a turndown of over 10 to 1. Said to provide extreme flame stability with as much as 300 per cent excess air, the oil burner is controlled simply through adjustment of the fuel supply valve, thus eliminating all moving parts and intricate burner adjustments.

Design of the new oil burner provides for uniform air distribution around the bell-flanged flame-retention nozzle — thereby providing an extremely stable, luminous flame of high radiation capacity. It is recommended by the manufacturer for use in forge furnaces, continuous and batch-type heating furnaces, heat-treating furnaces and other furnaces where small capacity burners are desired.

## COAL DUSTING SERVICE

▲ Coal brokers, users, and shippers who want clean, dust-free coal are being offered a new service by the Port Reading, N. J. piers. The Reading Railroad Co. is making available to all shippers through these piers a special treatment to allay dust. The service is offered at no extra charge but must be specified on the order.

The treatment consists of spraying the coal prior to shipment with a special chemical solution known as compound "M." This is a nontoxic and harmless preparation manufactured by Johnson-March Corp. The treatment in no way affects the burning qualities of the coal. It is said to eliminate more effectively the annoyance of coal dust in shipment, handling, and storage. This method of treating coal to eliminate dust has been used successfully by many other coal handling docks for the past five years.

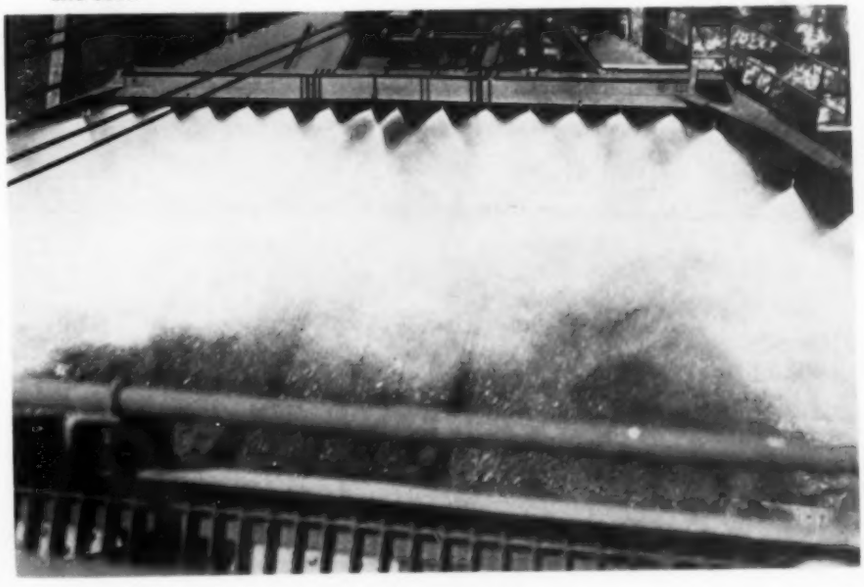
To provide this service, the Reading Railroad Co. has recently installed nearly $10,000 worth of new and modern equipment.

## SUSPENSION LAMP UNIT

▲ Thompson Electric Co. has announced the availability of a new lightweight 3-lamp cluster suspension unit designed for use with reflector lamp assemblies as well as conventional luminaires. Designated AL-8700, this suspension device will support three luminaires weighing up to 10 lb each. It is particularly suitable for application in industrial plants, aircraft hangers, foundries, gymnasiums, arenas, etc., because it provides for increased lighting capacity and efficiency without requiring installation of additional outlets.

The new unit features aluminum alloy construction throughout. Three

**A dust-free spraying service is being offered to coal shippers using the Port Reading, N. J. piers. The coal is treated with a nontoxic and harmless solution that eliminates dust without affecting the burning qualities of the coal.**



½-in. pipe-size tubes are used to support the fixtures. These tubes, threaded at fixture connection end, are slip-fit and securely locked by means of set screws in side hubs spaced 120 degrees apart on the junction box. Top hub of junction box has a ¾-in. female pipe thread connection and locking set screw.

When used in conjunction with the Thompson 4-pole (3-way 4-wire) disconnecting and lowering hanger, the unit can be lowered to floor level quickly and easily for safe, low-cost, efficient servicing of the luminaires. This type of installation also makes possible the use of either combination circuits with individual control of each light or combination mercury vapor-incandescent luminaires. The cluster also can be used with Thompson 2-pole hangers for applications involving incandescent lights connected in parallel.

## LOADING RESISTOR

▲ A new standardized loading resistor for load-testing the power plants of diesel-electric locomotives rated up to 2,500 hp is available from the Westinghouse Electric Corp.

This loading resistor, type TT-148, is a completely self-contained, compact unit that consists of 12 resistor trays, a motor-driven blower, knife switches, and measuring instruments. It is 42 in. wide, 46¾ in. deep, 104⅜ in. high, and weighs 3,500 lb.

The resistor sections are connected through knife switches and bus bars that make possible ten different series-parallel combinations to give ten load points. Resistor elements are mounted to provide maximum surface cooling and have slip-joint supports to allow expansion under load. Individual resistors can be replaced without disturbing adjacent elements.

The blower motor, which is mounted vertically at the base of the structure, is part of the resistor circuit, so no external source of power is required.

## DISCONNECT FUSES

▲ Electric Machinery Mfg. Co. has developed a new gang-operated disconnect method for de-energizing the fuses on high voltage motor control and for making them safe and convenient for handling.

The new high voltage fuse compartment, which has the trade name "SA-Fuse," uses a movable panel on which current-limiting fuses are gang-mounted. The fuse panel has disconnecting blades behind the panel. When the fuse compartment door is opened, the fuse panel is automatically pulled to the front of the compartment, disconnecting the fuse panel from the line, and putting the

(*Please turn to Page 204*)

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SPRAYING SYSTEMS descaling NOZZLES
If you want to materially reduce down time on rolling mills due to clogged nozzles, try Spraying Systems descaling nozzles. Large orifice diameter permits passage of practically all particles that ordinarily clog other types of nozzles. Spraying Systems nozzles produce an effective uniform flat spray, free of streaks, with an impinging force equal to over 96% of the maximum potential. Typical user is the Homestead District Works of U. S. Steel illustrated above. Nozzles are made of hardened stainless steel in a wide range of capacities and spray angles. Your inquiry is invited . . . write for Data Sheet 3997.
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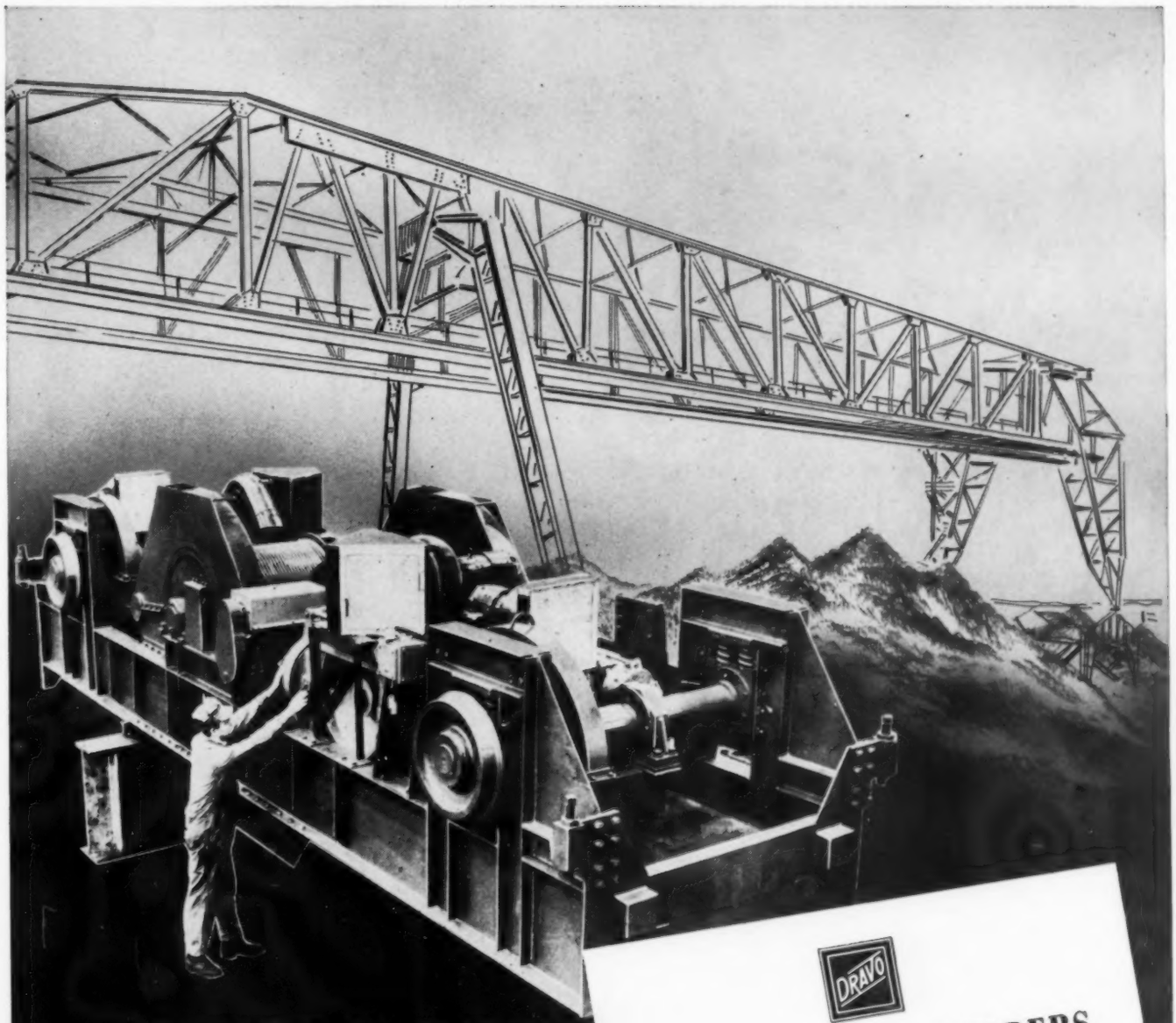
Also write for Data Sheet 4516 . . . Pneumatic Atomizing Nozzles for direct spray gear lubrication.



NORTH WESTERN-HANNA FUEL CO.'s unloading, stocking and reclaiming bridge has been modernized by the installation of a new 7½-ton man trolley, designed and fabricated by Dravo Corporation. Another trolley of this type was recently fabricated and installed by Dravo on a steel mill ore bridge.

Modernization such as this eliminates in many cases the need and expense of constructing a new bridge. New man trolleys improve existing bridge capacity and performance by providing faster and safer operating cycles.

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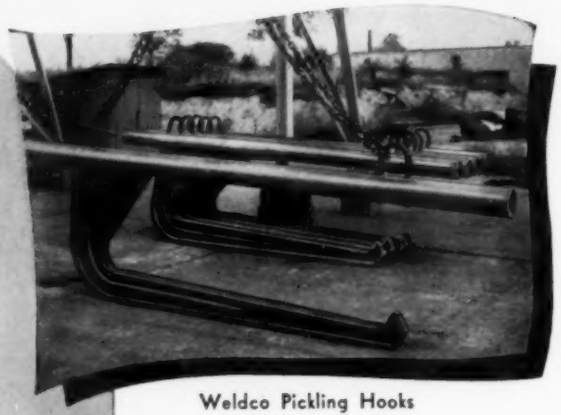
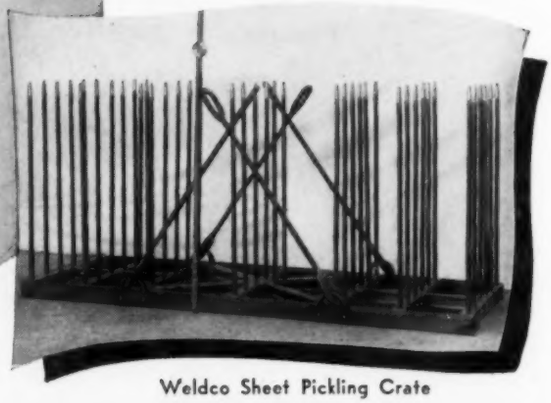
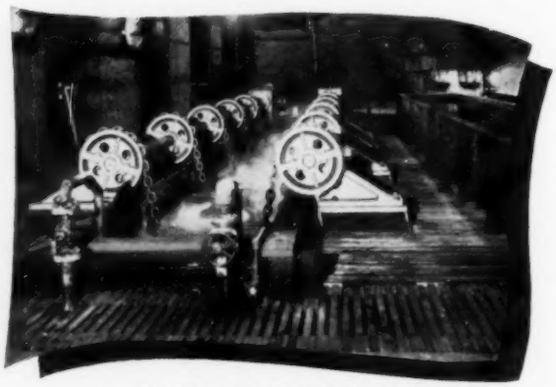


Weldco Pickling Hooks

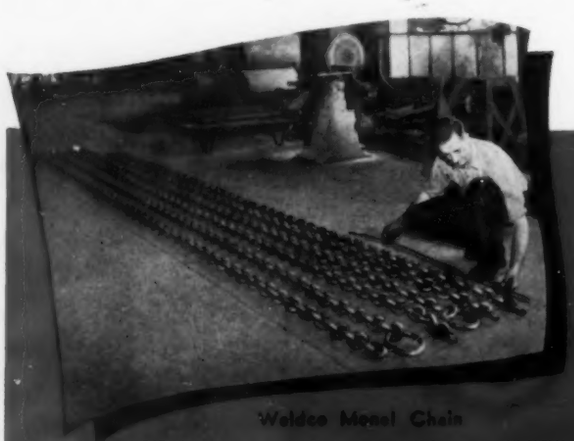


Weldco Sheet Pickling Crate



Weldco Mechanical Bar Pickler

Weldco Mechanical Coil Pickler



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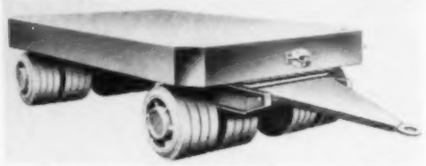
fuses within easy reach. The operator can then safely and easily remove and replace the fuses without a hook stick.

Mechanical and electrical interlocks prevent the fuses being disconnected when the switch is closed, and prevent closing motor switch with door open. Target indicators on door tell whether motor switch is opened or closed, and whether fuse panel is connected or disconnected. Door can be locked with fuse panel in either connected or disconnected position.

## HEAVY-DUTY TRAILER

▲ An industrial trailer with a capacity of 120,000 lb has been developed by Phillips Mine & Mill Supply Co. Equipped with eight, solid rubber-tired wheels, this heavy-duty trailer has a body framework of "I" beams and channels, with a deck surface of smooth steel.

The 120,000 lb-capacity "Phil-Trailer" is available in two styles: Model TF-1200, with fifth wheel on the front axle only; Model TD-1200, with fifth wheel on both front and back axles for extra maneuverability. To prevent tipping, the design features a wide wheel base and an exceptionally low center of gravity. Construction permits pulling either singly or in train by an industrial tractor.



Basic size of this trailer is 7 ft 6 in. wide by 12 ft long; however, it can be custom built to greater widths and lengths according to customer speci-

fications. It is recommended by the manufacturer for hauling heavy castings, forgings, finished components, dies and steel.

## AMPLIFIER SYSTEM

▲ Farmers Engineering and Manufacturing Co. has announced the "Femco" audiophone, an improved and simplified method of electronically amplified voice communication for industry.

These audiophones are offered as common talking systems, wired to order and consisting of press-to-talk, release-to-listen microphones and speakers at as many stations as are desired. Unless otherwise engineered to suit individual requirements for private two-way conversations, all stations hear simultaneously: directions, orders, warnings, or questions.

Power is drawn from 110 volt, 60 cycle lines with simple plug-in attachments. Output ranges from 10 to 150 watts or more. By use of multiple amplifiers and boosters, extensive networks can be installed and coordinated.

Components include various types of microphones and speakers for different applications, amplifiers, cabinets and accessories. All components are ruggedly built, compact and extremely easy to service when required.

With these audiophone systems, men at the controls can be brought within instantaneous voice contact with each other, even though they work at great distances apart.

Advantages include improved supervision, safety and teamwork with marked savings in production costs and time needed to "get things done."

Typical applications include steel mills, manufacturing plants, in mines —between levels and in processing operations, power generating plants and office—plant locations in light industry.

## D-C ARC WELDER

▲ A new 200-ampere, engine-driven d-c arc welder with a 60 per cent duty cycle has been announced by the

General Electric Co.'s welding department.

Designated as type WD-42AGW, the new welder has a current range of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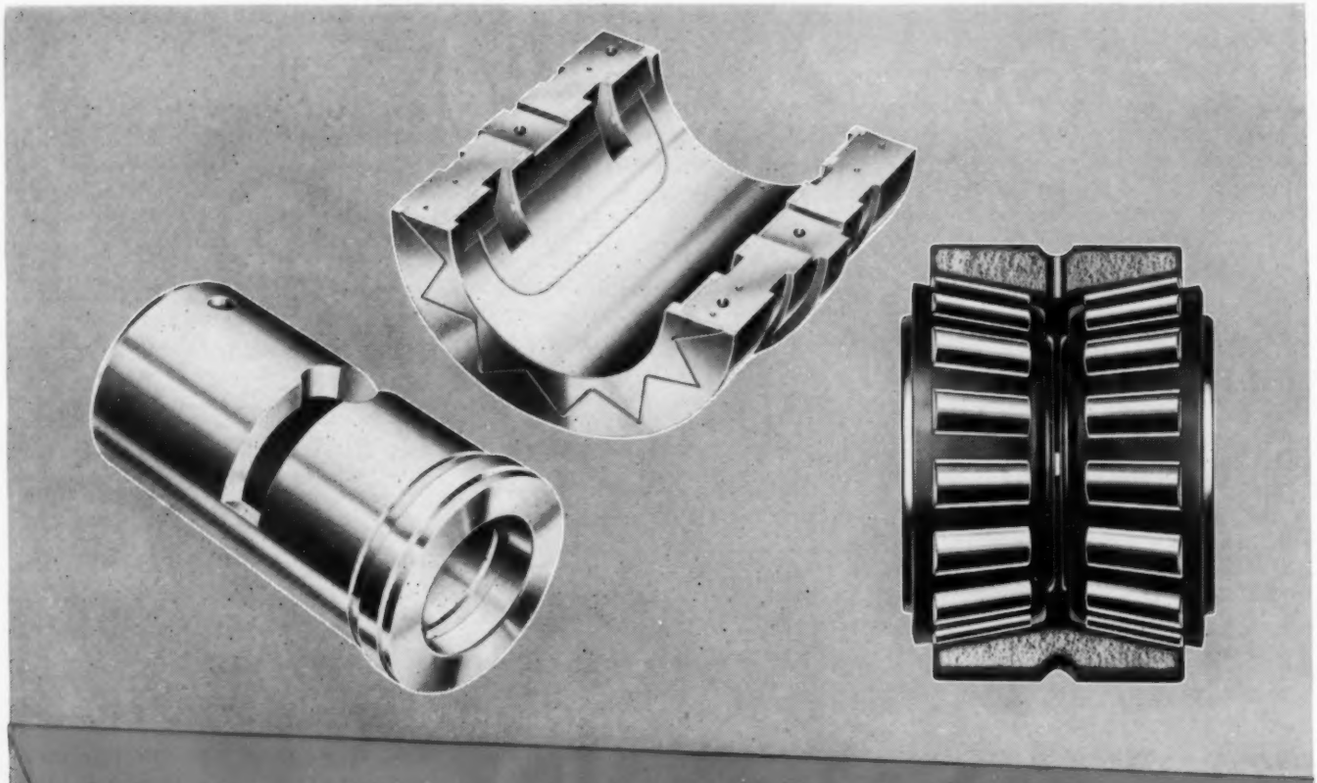

# How Gulf Periodic Consultation Service helps rolling mills cut lubrication and maintenance costs

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40 to 250 amperes, and can be used with a variety of electrode sizes for repair, maintenance, and construction work.

Consisting basically of a G-E type WD42 generator and a Wisconsin air-cooled engine, it is designed to fit crosswise in a standard pick-up truck. Optional equipment includes a trailer equipped with fittings for pressure lubrication.

Forced ventilation keeps internal temperature within safety limits when the welder is operated on a 60 per cent duty cycle at rated load. In addition, tests indicate that heavy overloads for short periods do not produce harmful results.

Maintenance-wise, either the generator or engine can be removed easily for overhaul, and replaced by a standby unit. Since the engine is air cooled, coolants or anti-freezes are not required.

A vacuum-type device saves gasoline by idling the engine when welding is not being done.

## MAGNESIUM YARD RAMP

▲ Magnesium Co. of America announces the addition of a portable magnesium yard ramp to its line of materials handling products.

The yard ramp has been designed to effectively solve a materials handling problem frequently occurring in industry today. This problem is to load and unload freight cars from the ground level because no dock facilities are available or existing facilities are congested.

The portable yard ramp may be obtained in five standard sizes, all of which are 30 ft long but vary in widths of 60 to 70 in. Capacities range from 6,000 to 16,000 lb, capacity being the combined weight of the load and the materials handling equipment transporting the load over the yard ramp.

The ramp incorporates the following safety features. Quarter round safety curbs with inner edges rounded to protect equipment are used along the top sides of the ramp. The ends of these curbs are capped with an end casting which tapers to each corner of the ramp. Bridge type underbracing offers maximum strength with minimum weight. A large wheel on each side of the ramp perfectly balances the weight, permitting one man to easily push and roll the ramp to the desired position for use.

The ramp in use is positioned in front of the freight car door and one end is raised by means of a hydraulic lifting mechanism. The lower end of the ramp is on the ground which prevents the ramp from being forced out of the car during loading operations.

## CENTRIFUGAL BLOWER

▲ When a centrifugal blower is used in the capacity range for which it was designed, pulsation is seldom a problem. There are, however, certain applications of blowers—where it is necessary to keep the blower running during periods of very small demand. In the case of certain heating processes these "turn-down" or "weekend holding" periods may call for as little as 10 or 20 per cent of rated volume output of the blower. In such cases, surging can set up a pulsation which may disturb the process and cause overheating and consequent damage.

Such pulsation can be prevented—and corrected—if one understands the mechanics of pulsation and the characteristics of a centrifugal blower, as here interpreted by O. W. Acheson, Billmyre Blower division, Lamson Corp.

The pressure-vs-delivery curves shown in the accompanying sketch are typical of all centrifugal blowers, the upper curve being of a well-designed blower, and the lower curve of a "not-so-well" designed blower. Note that in both cases the pressure attains a maximum high point at some relatively low rate of air output, the curve rising at air delivery rates below this critical value and descending at rates above this critical value.

If the demand on a blower is decreased in volume from a normal operating point, A, to another normal operating point, B, above the maximum-pressure point, the pressure at the blower merely rises correspondingly, and pulsation does not occur.


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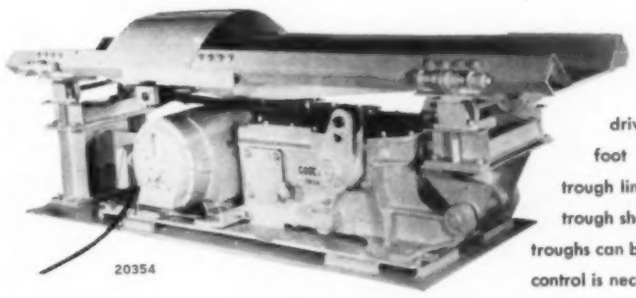
- Every Goodman Shaker Conveyor installation is specially engineered to suit job conditions.




A shaker conveyor drive unit and one 12-foot section of conveyor trough line. Curved piece over trough shows how entire line of troughs can be covered where dust control is necessary.

Your inquiry for complete details will receive prompt attention. No obligation, of course.

**GOODMAN MANUFACTURING COMPANY**
Industrial Manufacturing Division
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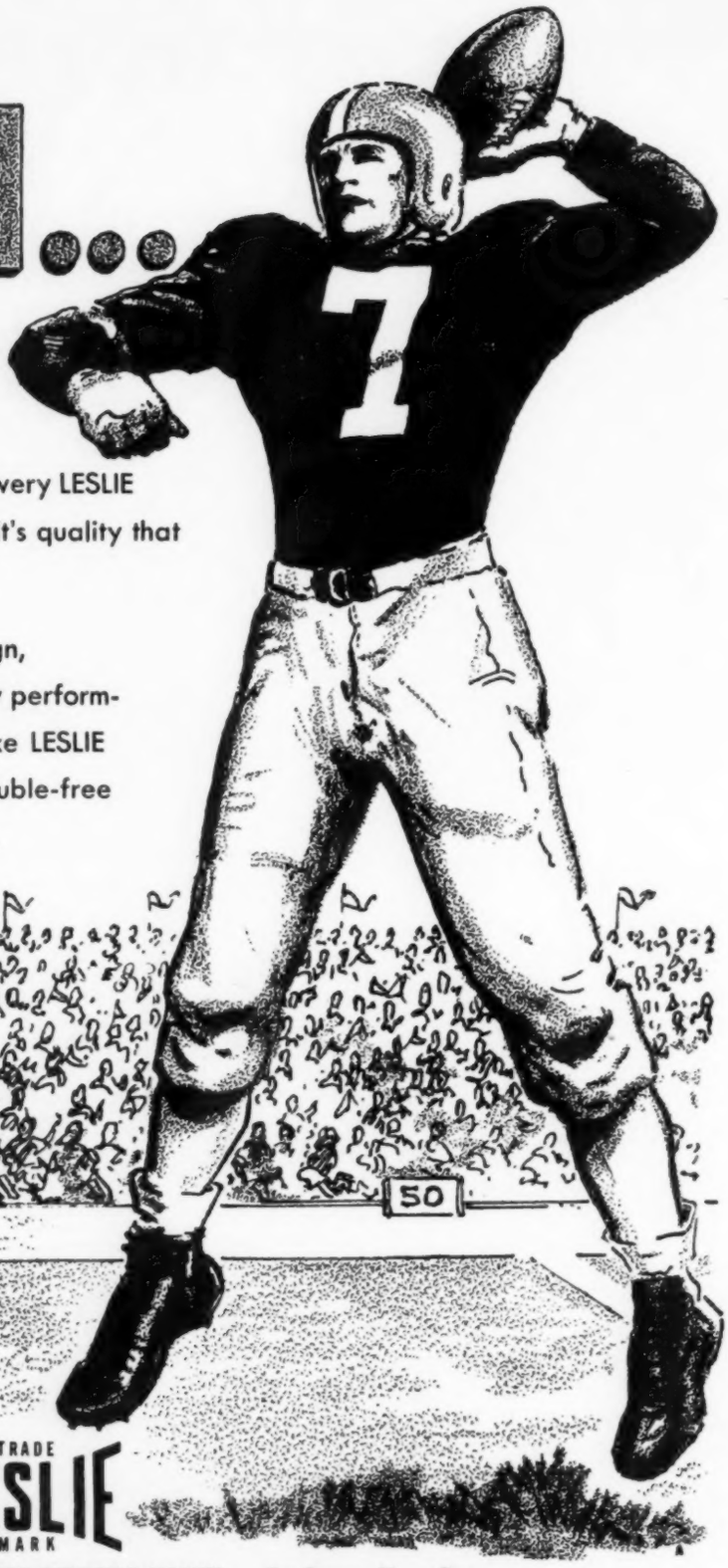
# Dependable Control...

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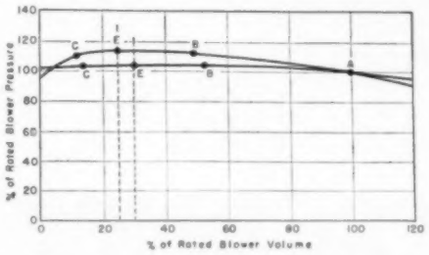
If, however, the load or volume requirement is decreased beyond the maximum-pressure point, E, to a very low point, such as C, the following sequence of circumstances may set up surging.

The blower delivery pressure first decreases from E to C at the blower itself. Thus for a moment, the pressure in the piping system connected to the blower is greater than the pressure at the blower itself. Thus the air in the line tends to reverse its direction and flow back into the blower (this can be extremely dangerous in handling gas to a burner or combustion chamber) until both pressures become equalized. When this is achieved the blower again resumes its normal function of pumping air into the system—until the restriction at the line outlet again reduces throughout and causes the sequence to repeat.

It is this repitition which constitutes surging.




The frequency and intensity of surging depends upon: (1) the slope of the pressure-vs-volume curve, (2) the rate at which air is being removed from the system, and (3) the volume of the pipe system to which the blower is delivering air. The same principles apply whether the centrifugal unit is operating as a blower or an exhauster.

The wisest action to take in the prevention of pulsation is the anticipation of circumstances which might cause it. The phenomenon will not occur in volumes above the point E. If the application is such that low turn-downs are expected, it is prudent to so indicate when the blower is being ordered. The blower manufacturer, can in most cases, select and specify to prevent pulsation.

If, however, pulsation or surging is noticed in a finished installation, any of the following four steps can be taken:

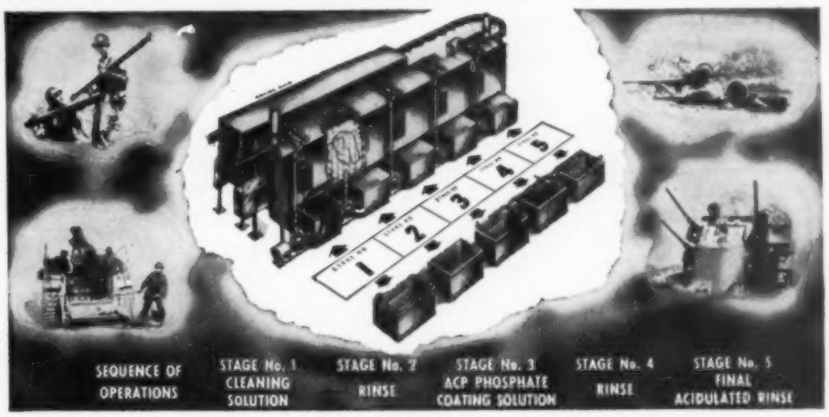
1. Consider the economics of replacing the blower with a smaller capacity unit having a consequently lower surge point.
2. Consider purchasing a small capacity unit for turn-down periods.


AMERICAN CHEMICAL PAINT COMPANY

AMBLER CHEMICALS ACP PROCESSES PENNA.

**Technical Service Data Sheet**

**Subject: METAL PRESERVATION AND PAINT PROTECTION WITH ACP PHOSPHATE COATING CHEMICALS**


SEQUENCE OF OPERATIONS
STAGE No. 1 CLEANING SOLUTION
STAGE No. 2 RINSE
STAGE No. 3 ACP PHOSPHATE COATING SOLUTION
STAGE No. 4 RINSE
STAGE No. 5 FINAL ACIDULATED RINSE

U.S. ARMY PHOTOGRAPHS COURTESY OF "ORDNANCE MAGAZINE"

**Typical spray and dip phosphating equipment and some ordnance products that are now given a protective phosphate coating for extra durability under all kinds of severe exposure conditions. Both military and civilian applications of ACP phosphate coating chemicals are shown in the chart below.**

SELECTION CHART OF ACP PROTECTIVE COATING CHEMICALS FOR STEEL, ZINC, AND ALUMINUM

| METAL | ACP CHEMICAL | OBJECT OF COATING | TYPICAL METAL PRODUCTS TREATED | GOVERNMENT SPECIFICATIONS |
|---|---|---|---|---|
| STEEL | "GRANODINE" Zinc Phosphate Coating Chemical | Improved paint adhesion | Steel, iron, or zinc fabricated units or components, automobile bodies, refrigerators, washing machines, cabinets, etc.; projectiles, rockets, bombs, rifles, small arms, belt links, cartridge tanks, vehicular sheet metal, tank bolts and links, recoilless guns, etc. | MIL-S-5002<br>JAN-C-490, Grade 1<br>JAN-F-495<br>U.S.A. 57-0-2, Type II, Class C<br>U.S.A. 51-70-1, Finish 22.02, Class C<br>U.S.A. 50-60-1<br>16 E4 (Ships) |
| | "PERMADINE" Zinc Phosphate Coating Chemical | Rust and corrosion prevention | Nuts, bolts, screws, hardware items, tools, guns, cartridge clips, fire control instruments, metallic belt links, steel aircraft parts, certain steel projectiles and many other components. | MIL-C-16232<br>U.S.A. 57-0-2, Type II, Class B<br>U.S.A. 51-70-1, Finish 22.02, Class B<br>Navy Aeronautical M-364<br>U.S.A. 72-53 (See AN-F-20) |
| | "THERMOIL-GRANODINE" Manganese-iron Phosphate Coating | Wear-resistance anti-galling, safe break-in of friction or rubbing parts. Rust proofing. | Friction surfaces such as pistons, piston rings, gears, cylinder liners, camshafts, tappets, crankshafts, rocker arms, etc. Small arms, weapon components. Hardware items, etc. | MIL-C-16232<br>U.S.A. 57-0-2, Type II, Class A<br>U.S.A. 51-70-1, Finish 22.02 Class A<br>Navy Aeronautical M-364<br>U.S.A. 72-53 (See AN-F-20) |
| | "GRANODRAW" Zinc-iron Phosphate Coating | Improved drawing, extrusion, and cold forming | Blanks and shells for cold forming, heavy stampings; tubs; tubing for forming or drawing; wire; rod; etc. | ——— |
| ALUMINUM | "ALODINE" Protective Coating | Improved paint adhesion and corrosion resistance | Aluminum products of similar design such as refrigerator parts, wall tile, signs, washing machine tubs, etc; aircraft and aircraft parts; bazookas (rocket launchers), helmets, belt buckles, clothes dryers, clothesline, rocket motors, etc., aluminum strip or sheet stock. | MIL-C-5541 (See also QPL-5541-1)<br>MIL-S-5002<br>AN-F-20<br>U.S. Navord O.S. 675<br>16 E4 (Ships)<br>AN-C-170 (See MIL-C-5541)<br>U.S.A. 72-53 (See AN-F-20) |
| ZINC | "LITHOFORM" Zinc Phosphate Coating Chemical | Improved paint adhesion | Zinc alloy die castings; zinc or cadmium plated sheet or components; hot dip galvanized stock; galvanneal; signs; siding; roofing; galvanized truck bodies; etc. | QQ-P-416<br>RR-C-82<br>JAN-F-495<br>AN-F-20<br>U.S.N. Appendix 6<br>U.S.A. 72-53 (See AN-F-20) |

CHEMICALS ACP PROCESSES

**WRITE FOR DESCRIPTIVE FOLDERS ON THE ABOVE CHEMICALS AND FOR INFORMATION ON YOUR OWN METAL PROTECTION PROBLEMS**

CHEMICALS ACP PROCESSES

3. Make sure that the amount of air by the blower is always above the surge point by bleeding enough air out of the system beyond the blower. If you are handling gas rather than air it will be necessary to recirculate this bleed flow back into the blower inlet. If you recirculate the bleed, however, remember that you are compressing and re-compressing that portion of the gas and building up the blower temperature to a point which may be detrimental.
4. If the surging is infrequent and of short duration, it may not be harmful to the blower at all. Surging at the point of air or gas use may be eliminated by adding a surge tank or increasing the cubical content of the piping in front of the nozzle.
5. Ask the manufacturer to make minor changes in the blower design to permit by-passing of the air, or take other steps which will eliminate the troublesome pulsation at the sacrifice of a little blower efficiency or tightness of the installation.

Actually, the more efficient a blower operates and the tighter the air system is beyond the blower, the more likely it is to surge at very low operating points. Fortunately, the uses for compressed air or gas, which demand blower operation at critically low output, are infrequent so that the use of high-efficiency equipment can be used in all but the rarest of cases.

## EC&M OPENS NEW OFFICE

▲ Electric Controller & Mfg. Co., Cleveland, Ohio, announce the opening of an office in the Washington, D. C., area at 8616 Georgia Ave., Silver Spring, Md. Mr. O. J. Archer will be in charge.

## SLAG POT WELDING

▲ A repair technique that will help maintain production in the face of the shortage of replacement parts uses submerged melt welding to repair cracks and holes in cast steel slag pots for open hearth furnaces. These vital parts have been repaired seven to eight times faster by "Unionmelt".

**Damaged slag pot being repaired by "Unionmelt" welding. Defective area is grooved with gouging nozzle; or cut out and a new section fixed in place by hand arc welding, which provides a backing for the welding.**


ALWAYS READY TO SERVE STEEL PRODUCERS

IN spite of the best of operating practice, blast furnace copper castings and steel mill bronzes wear out and must be replaced and replaced QUICKLY!

Blast furnace and steel mill new construction projects require copper and bronze castings ON SCHEDULE.

*Your experience* has convinced you that *you can expect immediate* and *scheduled* deliveries of QUALITY copper and bronze castings from THE FALCON BRONZE COMPANY.

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COPPER
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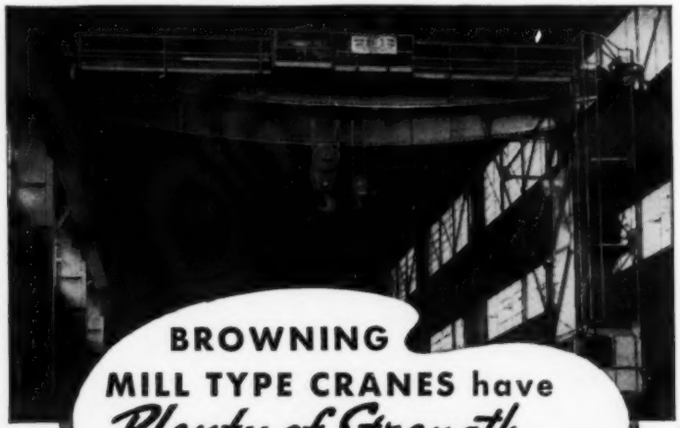
Established 1890 - Incorporated 1895



BROWNING MILL TYPE CRANES have *Plenty of Strength* WHERE STRENGTH IS NEEDED!

Browning Mill Type Cranes are built in accordance with A. I. S. E. specifications. They incorporate the types of motors and controls on which your mill or industry has standardized. This flexibility adapts your VRB crane *perfectly* to your needs. Only the finest materials are employed. Browning heavy duty cranes meet the most rigid demands and satisfy the most critical users. Our design, placing plenty of strength wherever needed, is the outgrowth of 48 years' experience in the crane industry.

"Built as you yourself would build them"

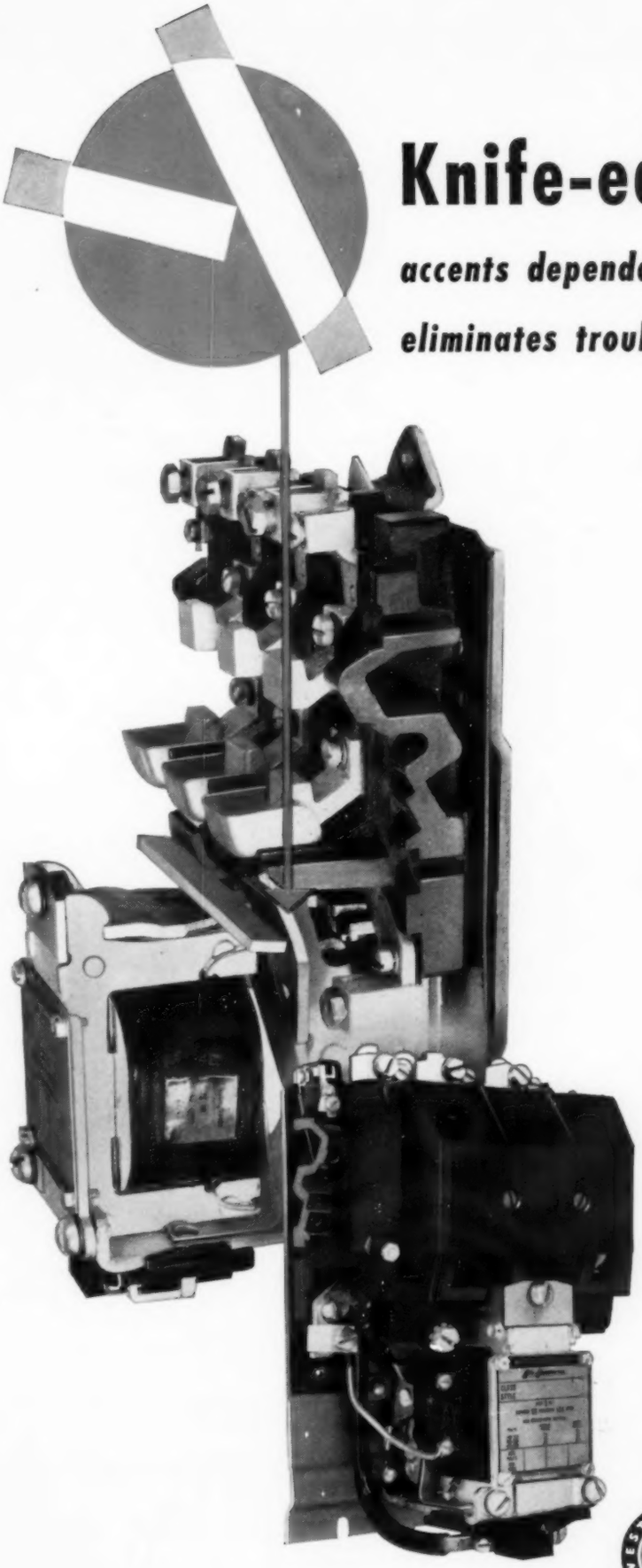
*Write for our Bulletin "E".*

VRB
VICTOR R. BROWNING & COMPANY, Inc.
BOX 309, WILLOUGHBY (CLEVELAND), OHIO
Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

# Knife-edge Action . . .

***accents dependability***

***eliminates trouble***



## in A-C "NR Contactors"

Long, trouble-free, dependable service . . . with Westinghouse NR Contactors!

Here you have a contact closing arrangement designed with fewer moving parts! The entire contact assembly pivots on a knife-edge of specially hardened steel. As a result . . . no sliding surfaces to bind or wear . . . no misalignment troubles. Friction is at a minimum! Jamming and sticking are eliminated! Nothing need be lubricated!

NR Contactors perform accurately. Positive-action, kick-out springs give sure contact openings—independent of gravity. You've got full protection against false operation from vibration or accidental impact.

The contact is double break, spring loaded, tipped with silver . . . which means constant high conductivity . . . no need for filing, dressing or cleaning. Westinghouse-developed "De-ion®" Arc Chamber snuffs out the arc in half cycle or less, thereby minimizing contact damage.

Yes, you get superior performance for any contactor application with Westinghouse NR Contactors.

Learn many other features and the performance story of these NR Contactors by asking your Westinghouse representative or writing directly to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21678

YOU CAN BE SURE... IF IT'S Westinghouse

CONTROLS

welding than with other methods, and the finished welds are as serviceable and strong as the original, undamaged slag pot.

Portable size apparatus makes there repairs easy and convenient for the operator. Since this method does not produce heavy fumes, operators do not need air respirators and the absence of glare also adds to welding ease.

While the present part shortage has increased the importance of repair, comparisons of replacement costs with costs of repair suggests that "Unionmelt" repair of damaged slag pots will outlive the present emergency. A new slag pot costs $1100 while repair expense varies from $20 to $150 depending on the extent of damage.

## SNOW PLOW PARTS

▲ Getting ready for next winter's snows, a large trucking concern has ordered a standard Yale 2000-lb capacity gasoline powered fork-lift truck equipped with a new, readily detachable combination snow plow and salt bin attachment.

**By means of a new attachment this standard Yale fork-lift truck may be converted into a snow plow. The plow and salt bin parts can be installed quickly to combat winter drifts.**

The attachment, which clamps on the forks, can be removed or installed in a matter of minutes to convert the truck for standard fork lift applications.

## PIVOT-BLADE SHEAR

▲The New Series 3C20 Steelweld shear, made by Cleveland Crane & Engineering Co., Wickliffe, Ohio, is the longest to date, with a shearing capacity of 20 ft by 3/16 in. steel plate.

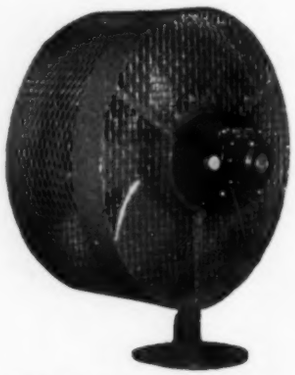
The pivoted-blade shearing principle is used, being a feature of all "Steel-weld" shears. This makes these shears entirely different from all other shears as the blade travels in a circular path without the use of customary guides and slides common

(*Please turn to Page 218*)

## CRANE CAB COOLER

**The operator of this furnace crane in the continuous weld department, Etna, Pa., plant of Spang-Chalfant Div., National Supply Co. no longer has to fight heat fatigue. Installed behind the cab is this Dravo cooler designed for these high-temperature conditions. It keeps the cab within temperature ranges of 80 to 85 F in summer and 68 to 72 F in winter. Fitted with supply and exhaust ducts, the unit provides continuous ventilation and removes dust, odors, gas and fumes from the incoming air.**

# *IS HEAT SLOWING UP YOUR WORKMEN?*



TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

**Keep them COOL with TRUFLO FANS**

TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

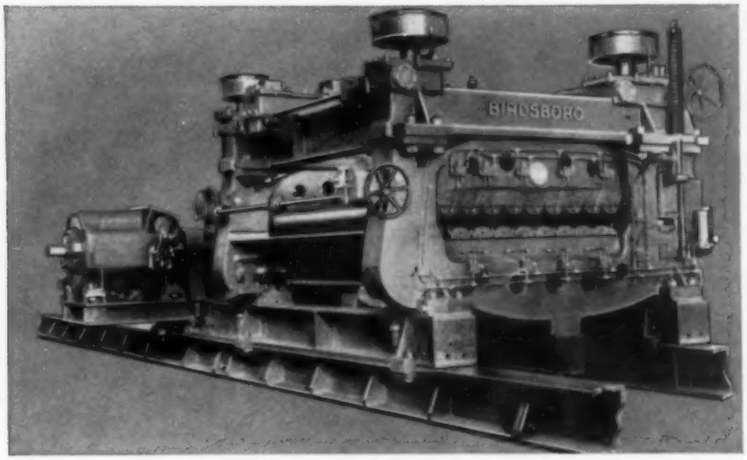
Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY

245 MAIN ST., HARMONY, PA.




*Leveling machine for hot carbon plate 3/16" to 1/2" x 100" wide.*

## STEP UP YOUR OUTPUT -- cut down your costs

# BIRDSBORO LEVELING MACHINES

On any leveling job—from heavy cold armor plate to light hot carbon plate — it takes smooth-running, maintenance-free levelers to produce volume output at minimum cost. Birdsboro precision levelers are designed, engineered, and built with this point in mind.

At your request, Birdsboro Engineers will put a diversity of design and engineering experience to work on your application to help you get the results you want.

*Precision leveler for cold alloy steel plate up to 1" thick and 160" wide.*

# BIRDSBORO

## STEEL FOUNDRY & MACHINE CO.

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*Offices in:* BIRDSBORO, PA. *and* PITTSBURGH, PA.

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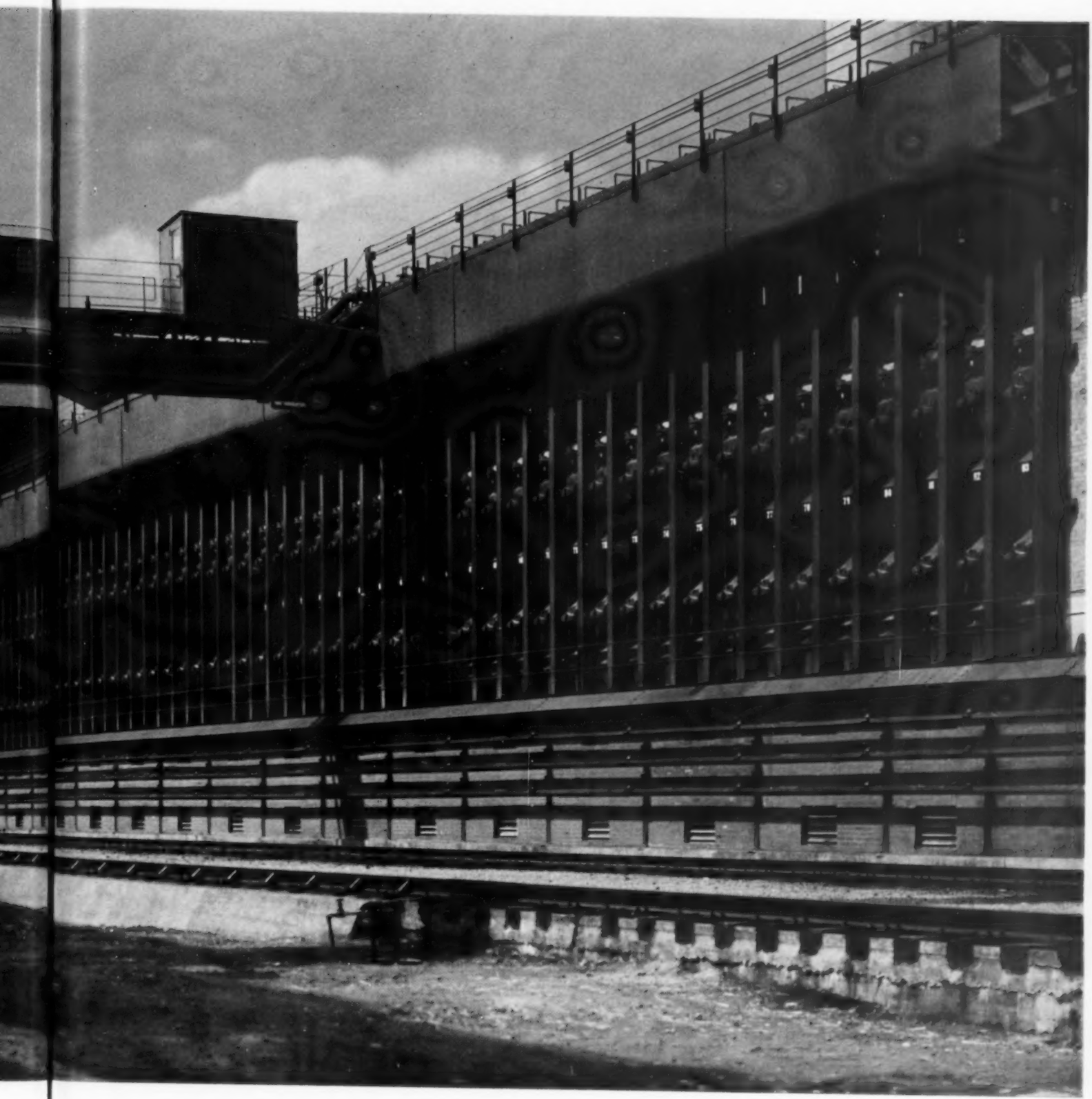
*a Wilputte Battery–*

83 underjet ovens
designed for
blast furnace gas underfiring
placed in operation for
The Steel Company
of Canada, Limited,
Hamilton, Ontario
during 1952

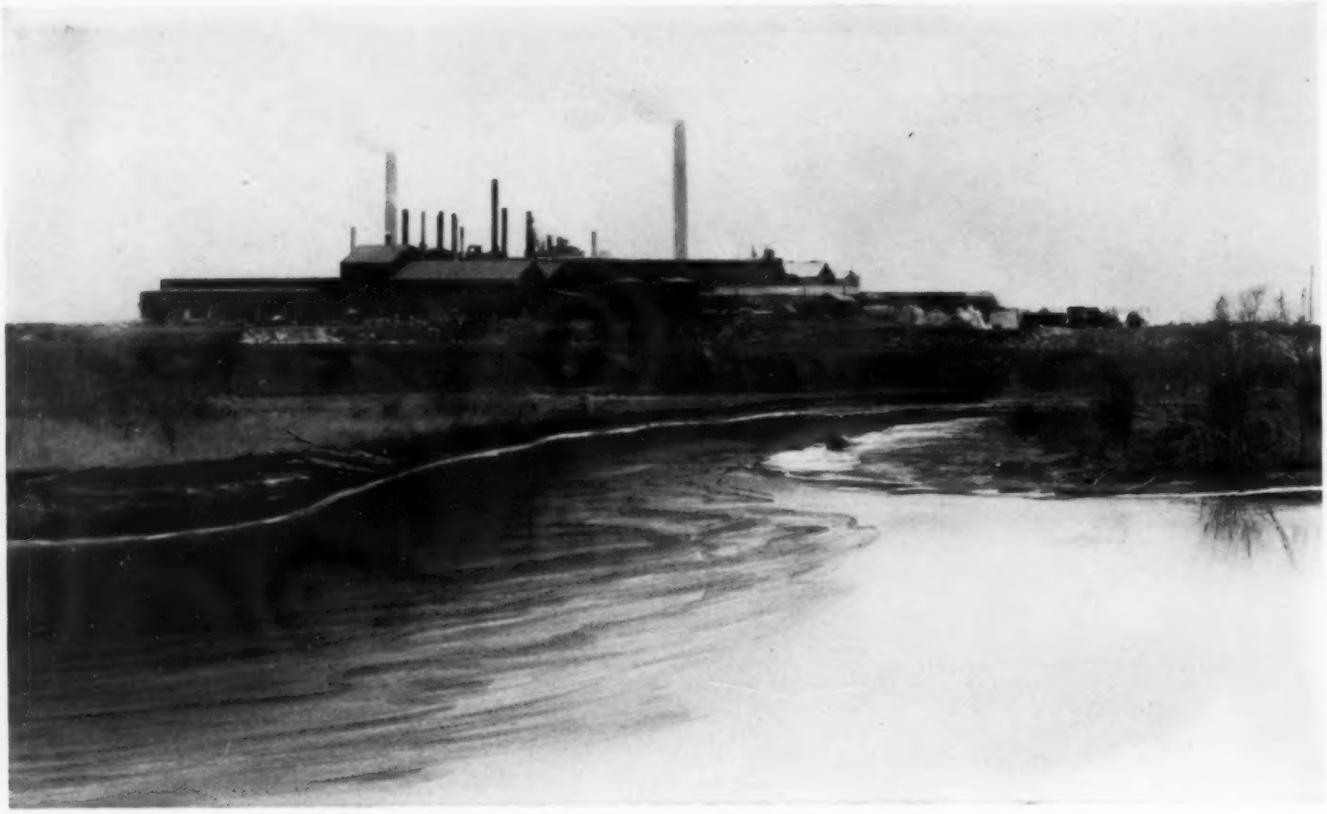
**WILPUTTE**



# COKE OVEN DIVISION

ALLIED CHEMICAL & DYE CORPORATION

40 RECTOR STREET • NEW YORK 6, NEW YORK



# WORRIED ABOUT WASTE DISPOSAL?

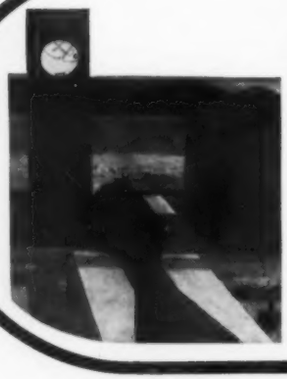
## Bailey Meters Help you to Reduce Pollution

● The disposal of industrial wastes without stream pollution calls for careful planning and continuous vigilance.

That's where Bailey Meters and Controls come in. We measure the flow and pH of sewage, sludge, and industrial wastes flowing in open channels or pipe lines. These and other factors, such as levels, rates of chemical feed, and flow of air, may be co-ordinated into a completely automatic system for the treatment and disposal of waste materials.

When you want fast, complete and authoritative answers to the measurement and control aspects of your waste disposal problems, reach for your phone and call your local Bailey Engineer. Offices in all principal industrial centers.

P-24



**BAILEY**
**OPEN CHANNEL METERS**

These indicating, recording and integrating meters are suitable for measuring industrial wastes, sewage, sludge, corrosive liquids, and irrigation water flowing in all types of open channel primary metering devices, such as Venturi flumes, weirs, or nozzle flumes. Electric or pneumatic telemetering permits location of receivers wherever desired. Ratio of flows and chemical feeds may be controlled automatically.

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For application to soaking pits, heating, and other types of metallurgical furnaces.
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### PITTSBURGH (Continued)

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204 Chemsteel Bldg., Walnut St., Pittsburgh 32, Pa.
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of pickling and other tanks; flooring.
(TEAR OUT & MAIL WITH LETTERHEAD)

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**TRABON ENGINEERING CORP.**
***"Centralized Lubricating Systems"***

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Clamshell — dragline — grab's
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**FOR SALE**
1600 CFM Ing.-Rand Horiz. Air Compressor, PRE-2, 14" x 23" x 16" cylinders, 100 PSI, 300 HP Westinghouse Motor, 2300 V, 225 RPM. Complete.
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**MILL OPERATORS' PULPITS**
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### POSITIONS VACANT


**ENGINEER**

"With technical education and ten to fifteen years of experience in design and development of heavy machinery or similar experience, for research and development work both as to design and from industry study points of view. Permanent position with opportunities to grow are involved in expanded program of well established heavy machinery, rolling mill and hydraulic press builders. Location Pittsburgh. Write complete details of experience, pertinent personal information, and enclose photograph in first letter. Salary $7000 to $9000 per year, depending upon experience." Box 1101, IRON AND STEEL ENGINEER, 1010 Empire Bldg., Pittsburgh 22, Pa.


### POSITIONS WANTED


**ELECTRICAL LINES WANTED!**

Established manufacturers agent is desirous of representing an additional electrical equipment or supply firm in the Western Pennsylvania, West Virginia, and Eastern Ohio area. Box 1102 IRON AND STEEL ENGINEER, 1010 Empire Building, Pittsburgh 22, Pa.

**Administrative Staff or Operating Management**

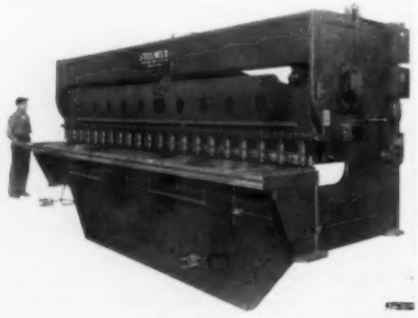
Mechanical engineer with 17 years experience in steel mill metallurgy engineering and operations. Also experience in rolling mill cost and procedure work. For past 5 years engaged in plant administrative and operating management and for 3 years in foreign steel mill operations. Box 1103, Iron and Steel Engineer, 1010 Empire Building, Pittsburgh 22, Pa.


## EQUIPMENT NEWS

(*Continued from page 212*)

with guillotine-type shears. Therefore, difficulties from wear at these points are eliminated.

The machine is operated by electric foot switches which can be moved about the floor to the most convenient working position. Foot switches substitute tireless toe action for tiresome knee action required by the conventional foot treadle which is ordinarily used to operate a clutch mechanically. Two electric foot switches are provided for this machine and it may be operated by either one. The switch not in use can be locked out of the circuit. If two men are working at the shear, the switches can be so arranged by a key-operated control lock that both must be depressed simultaneously before cutting action will begin.



A new design clutch-brake mechanism makes possible greater shearing output than ever before. It enables feeding the material to it as fast as the machine will take it. The speed is 55 strokes per minute. The mechanism, which is operated by air, is unusually fast acting, providing quick, positive clutching or braking with very little slippage. Thus, wear and heat are reduced to a minimum. The design permits easy accessibility for adjustment and maintenance.

The back-gauge is motor-driven with control buttons located at middle front. Just below the buttons is located the indicator, visible through an oblong slot in the hold-down beam. With this arrangement, the need of frequent trips to the rear of the machine is obviated and time saved.

A chain-driven rotary limit switch stops the knife at the top of the stroke. It is positive in action and easily adjusted and one of the many safety features.

One of the advantages of the shear is the ease with which knife clearance can be adjusted to suit thickness of metal being cut. It is simply a matter of turning a convenient hand crank and observing a large dial indicator. When the hand is on the figure representing the plate thickness, the machine is ready to cut. This adjustment is easily made in a matter of seconds and makes possible better, sharper, burr-free cuts, as well as less wear on the knives.

The frame is solidly built with all sections of steel plate welded, thus assuring non-movement of parts and life-time alignment.

## *Book Reviews . . .*

▲ The following standards have just been published and are available from NEMA Headquarters: NEMA Standards for Direct-connected Steam Turbine Synchronous Generator Units (2,000-10,000 kw, inclusive). Publication No. TU4-1952. These standards provide practical information concerning the construction, rating, manufacture and performance of direct-connected steam turbine synchronous generator units rated from 2,000 to 10,000 kw. inclusive. 16 pp. $0.75 per copy.

NEMA Standards for Feeder Voltage Regulators. Publication No. FR1-1952. This publication contains all of the existing standards which have been approved by NEMA on feeder voltage regulators. It covers the rating, testing, performance and manufacturing of step and induction voltage regulators. Terms used throughout the publication are defined. 32 pp, $3.00 per copy.

NEMA Standards for Industrial Rectifier Units (Ungrounded 2-wire Service) (Sealed-tube Type). Publication No. 223-1952. Industrial rectifier units which supply power at essentially constant direct-current voltage to ungrounded 2-wire direct-current utilization systems are covered in this book. Information is given concerning enclosures, arrangements, ratings, alternating-current switchgear, rectifier transformer, rectifier section, direct-current switchgear and rectifier control. 16 pp, $1.75.

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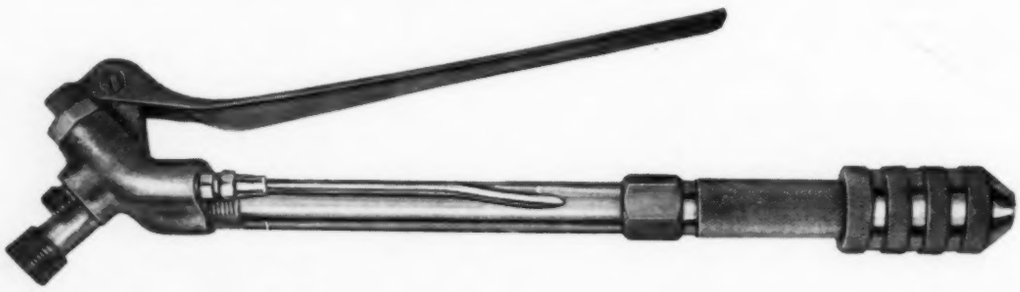

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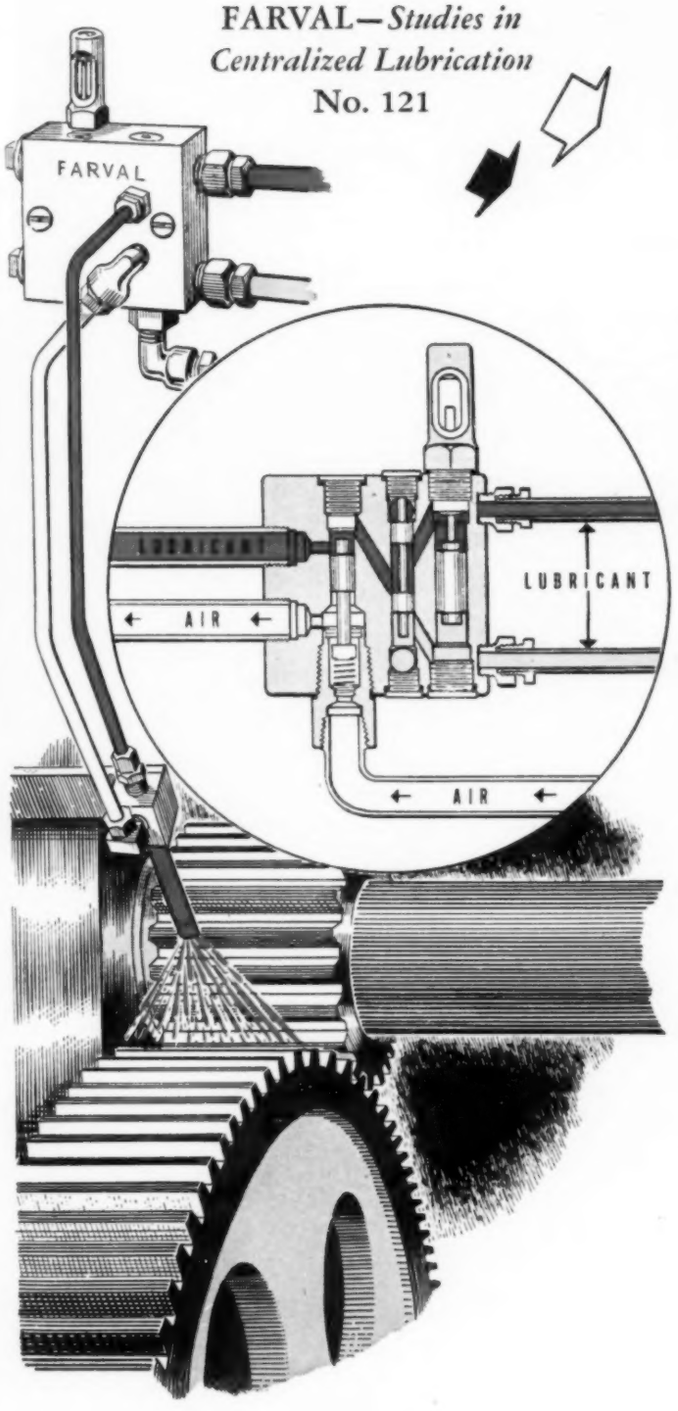


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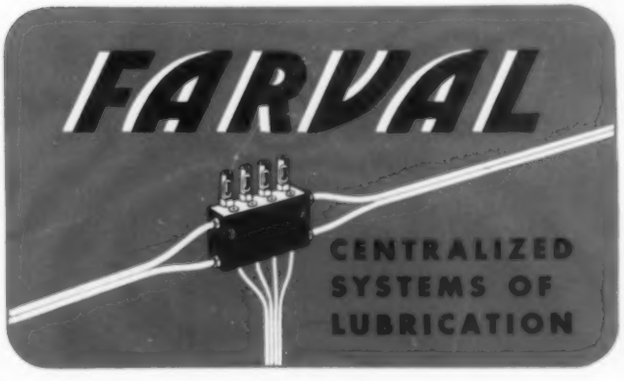

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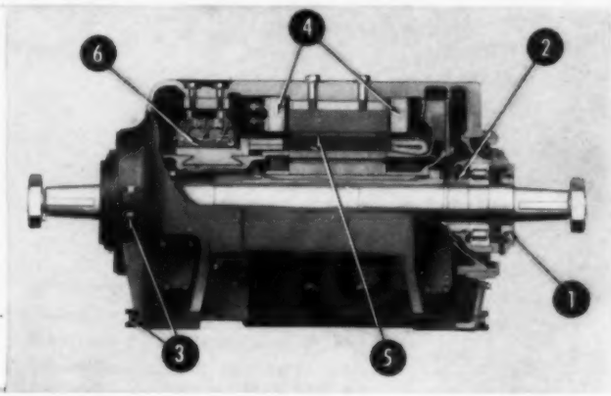


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